THURSDAY, MARCH 6, 1879

COAL AND COAL-MINES

A Treatise on Coal, Mine-Gases, and Ventilation. By J. W. Thomas. (London: Longmans, 1878.)

MR. THOMAS is known to chemists by reason of the numerous and excellent analyses of the gases inclosed in various coals which he published some time ago in the *Journal* of the Chemical Society. Marsilly in France, and Meyer in Germany, first broke ground on this subject, but it is to Mr. Thomas, who very greatly improved the method of research, that we owe our most exact knowledge of the character of these occluded gases. The matter is of considerable importance from a twofold aspect. It not only serves to throw light upon the scientific question of the formation of coal, but also affords us information on the very practical question of the nature of the influence of the atmosphere upon the deterioration of coal. These observations attracted sufficient attention from mining engineers and persons connected with mining to induce the author to reprint them together with other matter relating to the general subject, and the result is the volume before us—a work which it is not too much to say ought to be in the hands of the manager and sub-officers of every colliery in the kingdom. Although the subjects of gases in coal and of the deterioration of coal by atmospheric influences are treated at considerable length, the relative or connected matter occupies by far the greater portion of the book, and we have chapters on the Diffusion and Transpiration of Gases, Explosions in Mines and Ships, Combustion, Ventilation, &c.

The opening chapter is occupied by a discussion of that most vexed of questions, What is Coal?—a question which has already cost some people much patience and more money to get answered, but hitherto without success. We are bound to say our author does not help us towards a solution; we are apparently as far off as ever from a scientific definition of this everyday commodity. His remarks on the classification of coals are extremely just. It is not surprising, from the author's connection with the South Wales Basin, that the particular subject of anthracite should receive special attention at his hands. The origin of this form of mineral fuel has given rise to much discussion in the past, but it is only within recent time that the opinion that it is not necessarily the oldest transition-product in the decay or alteration of vegetable matter has begun to gain ground. Our author throws considerable light on the process which has been at work in the formation of anthracite, from a study of the composition of the gases which are found inclosed in this class of coal. He regards the process of the formation of coal (after the first or primary decomposition which ensued during the time the vegetable matter was in the act of being buried) to have taken place in four ways, viz.:—

1. The dry process aided by heat, leading to the production of anthracite.
2. The dry process without much abnormal heat, to which the production of steam coal and Wigan cannel is due.
3. The wet process with heat, to which may belong the production of Scotch cannel and the more dense varieties of bituminous or house coals.
4. The wet process without long-continued heat, to which we may assign the formation of ordinary bituminous (house coals) and lignite.

With respect to the nature of the material from which coal has been originally derived, Mr. Thomas has little or nothing to add to what is commonly stated in popular works on the subject. To dismiss the spore-theory in some six or eight lines, with the assertion that "there is little evidence of a weighty character to confirm this hypothesis," is, in the light of existing facts, scarcely just to the researches of Carruthers, Morris, and Huxley. To say that all coal has been derived from lepidodendroid spores would unquestionably be incorrect, but to assert that many coals have been largely derived from such material is undoubtedly true. This much, we suppose by this time, is conceded by the majority of authorities on the subject: the difference between them is rather as to the proportionate part played by the spores.

As regards the character of the gas occluded in coal, this depends not merely upon the structure of the coal, but upon the conditions under which its formation has occurred and the depth below the surface at which it is situated. On the whole Mr. Thomas's analytical results agree fairly well with those of Dr. Meyer, in spite of the somewhat faulty method adopted by the latter; but the inferences which the two experimenters draw from their observations are not unfrequently opposed. There seems to be a decided difference between the gas inclosed in lignites and that found in coals of the older formations. Zitowitsch first detected carbonic oxide in some specimens of Bohemian lignites, and the author has detected the same gas in appreciable quantity in the well-known lignites of Bovey Heathfield, in Devonshire. On the other hand, no coal of the carboniferous period has been found to contain this gas. Another characteristic difference between the coals of the carboniferous and tertiary periods is seen in the absence of all hydrocarbons among the gases occluded in the latter varieties.

The presence of carbonic oxide in "after-damp" has been frequently surmised, but Mr. Thomas brings direct evidence to prove the fact. Until quite recently it was the general belief among chemists that when marsh-gas—the "fire-damp" of the miners—is mixed with less air than is required for complete combustion, only as much of the hydrocarbon is burnt as the oxygen present can convert into carbon dioxide and water. It is now found that when marsh-gas is exploded with a quantity of oxygen or air insufficient for complete combustion, the *whole* of the marsh-gas disappears into carbonic oxide, carbon dioxide, water, and free hydrogen. The importance of this observation is obvious. It has not unfrequently happened that after an explosion the expressions of the countenances of the victims, who have been found sitting or leaning in the most natural positions, have worn no trace of fear or intense anxiety, such as we should suppose would come upon them amidst the roar and wreck of the disaster. These men have not been asphyxiated by carbonic acid or drowned in excess of nitrogen: they have been struck down by the infinitely more deadly carbonic oxide. Instances too have occurred in which the explorers after an explosion have been almost as suddenly

overwhelmed, even when their lamps were burning freely. These facts point to an entirely different mode of treating those who have been rescued and who are still suffering from the effects of after-damp, from that which has been hitherto adopted. It is not too much to say that many a life could have been saved if, acting on Hoppe-Seyler's observations, artificial respiration could have been maintained for some time after apparent death.

There is much in this book that we should have liked to have dwelt upon had space permitted, for almost on every page we discern evidences of originality and freshness such as might be expected from one who, as we have seen, has brought the researching spirit to bear upon his subject. Whilst chemists are wearying themselves and others with vain speculations as to bonds and atomic-groupings, far too many of the common matters of every-day life are thrown aside as unfruitful or worked out. No one, however, could take up this book and not see that in the matter upon which it treats there are fifty problems waiting for solution—some of them most pressing in the interests of humanity, and any one of them capable of yielding a rich harvest of facts. T. E. THORPE

THE MORPHOLOGY OF THE ECHINODERMS

Morphologische Studien an Echinodermen. Von Dr. Phil. Hubert Ludwig, Director der naturwissenschaftlichen Sammlungen in Bremen. 1 Band mit 23 Tafeln und 5 Holzschnitten. (Leipzig: Verlag von Wilhelm Engelmann, 1877-79.)

WITHIN the last three years very numerous researches have been made on that most interesting group, the Echinoderms, to which, we are glad to see, the rank of a distinct sub-kingdom is now generally assigned. Greeff, Götte, Lange, Ludwig, Simroth, and Teuscher, in Germany; Perrier in France, Théel and Lovèn in Sweden, Agassiz, Lyman, and Pourtalès in America; and in our own country Sir Wyville Thomson, Duncan, Sladen, and the two Carpenters, father and son, have each contributed more or less to our knowledge of the morphology and physiology of the group.

Of the many observations made and recorded by the above-mentioned naturalists, those of Dr. Ludwig ("Eibildung Ludwig," as we have heard him called by embryologists) seem to us to be among the most important, alike from their variety, and, as we are strongly inclined to believe, from their general accuracy. We are not so sure, however, that all Dr. Ludwig's conclusions are as correct and reliable as his observations are trustworthy, for there are certain points on which we have very strong grounds for dissenting from his views.

The volume before us, representing the result of three years' work, mostly microscopic, is the first of a promised series of studies in Echinoderm morphology, and consists principally of memoirs on the anatomy of Crinoids and Starfishes.

It contains much that is new, or rather that was so when the individual memoirs were first published in the *Zeitschrift für wissenschaftliche Zoologie*, and much that is to be found, stated more or less correctly in the writings of other workers, both before Ludwig and contemporaneous with him.

The first paper in the series, forming about one-third of the whole volume, is devoted to the anatomy of Comatula. While generally confirming Dr. Carpenter's results, respecting the canals of the arms and the chambered organ, Ludwig (whose observations on this type were contemporaneous with those of four other observers, two in Germany and two in this country) publishes several new and interesting anatomical details.

Among the most important of these is the presence of blood-spaces around the genital organs, and also of a system of blood-canals ventral to the water-vascular system. Both of these systems probably communicate with the vascular "axial prolongation" of Dr. Carpenter, which runs up into the disc from the chambered organ situated in the calyx, and represents the "heart" of the Starfishes.

Ventral to the radial blood-canal is the fibrillar sub-epithelial band, to which Dr. Ludwig assigns a nervous character from its resemblance to a similar and similarly placed structure, that is generally, though not universally, supposed to be the nerve of the arm of a Starfish.

Ludwig's views have been completely adopted by Gegenbaur, in spite of the fact that this band is absent from half, or sometimes from more than half, the arms of many Comatulæ. We scarcely think that Ludwig has taken this fact sufficiently into consideration in his discussion of Dr. Carpenter's suggestion that the axial cords of the skeleton constitute the chief nervous system of Comatula; and we are not altogether satisfied with the purely diagrammatic manner in which he figures this axial cord, and with the meagre description which he gives of it. He makes no mention whatever of the regular manner in which it gives off branching bundles of fibres to the muscles and other structures in the middle of every arm-joint, except in quoting their discovery by others, though he cannot well have helped seeing them, and he does not deny their existence. At the same time he seems inclined to admit the probative force of Dr. Carpenter's experiments at Naples, which tend to show that these axial cords are the *motor* nerves, at any rate of the complex Crinoid organisation, permeated though they may be by a coagulable fluid. Should this view be the true one, it is another argument in favour of Leuckart's separation of the Crinoids and their allies from the other Echinoderms, to form a distinct class, the Pelmatozoa.

Until lately the Crinoids have not been credited with an ambulacral system homologous with that of the other Echinoderms. Götte, however, has shown that, as far as development is concerned, this is not the case, and the true water-vascular ring of the adult Comatula was first described by Ludwig, though its radial branches in the arms have long been known. Depending from it into the cœlom are numerous small tubules which Ludwig describes as open at the ends, and compares to the sand-canals of the other Echinoderms, more especially of the Holothurians.

After finishing his researches on the anatomy of Comatula, Ludwig turned his attention to Rhizocrinus, and found that it corresponds with Comatula in all essential points of structure. This was the first stalked Crinoid in which the presence of a chambered organ was determined. It has since been found in Pentacrinus and Bathycrinus, and Ludwig's discovery that its chambers are continued down the axis of the stem as five blood

canals disposed around a central axis, has received abundant confirmation.

The curious genus Rhopaladina has been supposed by some writers to be the type of a new group of Echinoderms, with mouth, anus, and genital opening at the centre of one of the poles of the body. Ludwig shows, however, that it is merely an aberrant Holothurian, much bent on itself, owing to the almost complete disappearance of the medio-dorsal inter-radius, an exaggeration, in fact, of a condition very commonly met with in Cucumaria. Ludwig's memoirs on the Asterids contain several novelties, two of the most important of which are as follows:—

1. The pores in the madreporic plate have no communication with the cœlom, but lead solely into the sand canal. The same fact has been noted by Perrier for the Echini, and it is the more singular because the body cavity of the Crinoids is in free communication with the exterior.

2. The genital glands do not discharge their products into the body cavity, but are provided with longer or shorter ducts that open directly on the exterior of the body. Around the glands are blood spaces, just as in the Crinoids, and these are connected with a very complicated blood-vascular system, which Dr. Ludwig describes exceedingly well, clearing up many points which had hitherto been very obscure and scarcely understood. This is especially the case with the remarkable genus Brisinga, which Sars supposed to be without a blood-vascular system. Ludwig contributes many valuable observations to the anatomy of this type, and shows that in all essential features it is a true Asterid, though he does not share Sars' views of its relationship to Protaster.

The volume closes with a striking paper on the Ophiurids, in which it is shown that the whole of the oral skeleton of the disc is the result of modifications of the first two arm-vertebræ and of the adambulacral and superambulacral plates corresponding to them. But the chief novelty in this paper relates to the genital clefts. These have been hitherto supposed not only to let the genital products pass out of the cœlom, but also to admit water into it. Ludwig shows, however, just as in the case of the Asterids, that both these hypotheses are incorrect. The sexual products are not discharged into the cœlom, nor does water enter it by the clefts, but the latter open into pouches or bursæ which are merely involutions of the general integument of the body, and receive the short ducts of the genital glands, probably serving also as a respiratory apparatus. Their inner surface, that turned towards the cœlom, is curiously folded, and their whole structure is so very similar to that of the hydrospires of the Blastoidea that Ludwig is led to suggest a homology between these two sets of similarly placed organs. Billings considered the hydrospires to be respiratory in function, and found them to be connected with the "spiracles" or genital openings, which would thus be homologous with the genital, or, as Ludwig prefers to call them, "bursal" clefts of the Ophiurids.

Should further investigation confirm this interesting discovery of Ludwig's, and the conclusions he has drawn from it, we quite agree with him in regarding it as one of great importance respecting the relations of the various echinoderms *inter se*.

We shall look with great interest for the publication of Dr. Ludwig's promised researches on the Echini and Holothurians at, we trust, no distant time; and also for his concluding work on the comparative morphology of the sub-kingdom as a whole, which will not, we imagine, be altogether a pillar of strength to Haeckel's celebrated "Worm Theory of the Echinoderms."

OUR BOOK SHELF

Jornal de Sciencios Mathematicas Physicas e Naturaes. Publicado sob os auspicios da Academia Real das Sciencias de Lisboa. No. xxiii. agosto de 1878. (Lisboa, 1878.)

Giornale di Matematiche: ad uso degli Studenti delle Università Italiane. Pubblicato per cura del Professore G. Battaglini. Vol. xvi. (Napoli, 1878.)

WE have not seen any previous numbers of the first of these publications, but from the specimen before us we should certainly conclude that this Society is doing good work. In fifty-two octavo pages we have specimens of work in all the lines indicated in the above title. The opening paper, by C. A. Moraes de Almeida, is an "estudo geral dos espelhos curvos" (continuation, 11 pages); Chapter IV. treats of spherical, elliptical, and parabolical mirrors of very small aperture; Chapter V. discusses some cases of practical difficulty in the formation of images. The second paper is a mathematical one by L. F. Marrecos Ferreira; 1st part, on the geometrical properties of the intersections of right cones, derived from the principle of the homological transformation; 2nd part, on the properties of conics tangential to the sides of an angle and their application to the study of surfaces (18 pages). Both papers are neat, and contain interesting properties.

Zoology follows, with two contributions by J. V. Barboza du Bocage, first with a list (the sixteenth) of the birds in the Portuguese possessions in West Africa (15 pages), next under the title "Mélanges Ornithologiques," remarks on new species of Angola (*Nectarinia anchietæ*[1]) and on individual birds of the families Certhiidæ (*Hylypsornis Salvadori*), Paridæ (*Parus rufiventris*), Laniidæ (*Lanius Souzæ*, *Nilaus affinis*).

The last two pages contain a slight account of 111 plants, collected in Caconda by Signor Anchieta. Remarks are made on the points of contact between some of the plants in this collection and that got together by the late Dr. Welwitsch.

The second journal maintains its reputation for its contributions to the study of geometry. Where there is so much to praise we must limit ourselves to giving here the bare titles of some of the longer papers:—Ricerche geometriche sopra alcune proprietà dei sistemi di rette nel piano e dei sistemi di circoli che passano per un punto sul piano e sulla sfera, per T. Fuortes (56 pp.); Sulla riforma dell'insegnamento geometrico, nota di G. Fiedler seguita da tre lettere inedite dell' autore (13 pp.); Sull' infinità circolare non Euclidea, per G. Battaglini (7 pp.); Relazione fra l'area e il perimetro, fra il volume e la superficie, fra i momenti, fra le coordinate dei centri di gravità per gli spazi limitati da linee e superficie che hanno l'equidistante della stessa natura per U. Dainelli (20 pp.); Sulla teoria delle quadriche omofocali del punto di vista sintetico per F. Maglioli (36 pp.); Nozioni preliminari per la geometria projettiva dello spazio rigato, Nota i di F. Aschieri (19 pp.); Sopra le curve piane del 3° ordine con un punto doppio, per P. Anelli (14 pp.).

The History of Coal. By the Rev. T. Wiltshire, M.A. F.G.S., &c. (E. and F. N. Spon, Charing Cross and New York. Pp. 36, 1878.)

THIS pamphlet is the introductory lecture which the

[1] So named from the finder, who met with a single specimen, October, 1877, in the interior of Benguella.

author, as Dean of the Evening-class Lectures at King's College, London, delivered before the Principal, the staff, and students, at the commencement of this Winter Session.

It deals with the antiquities of coal, and as might have been anticipated, shows much patient scholarship and research amongst the works of those classical and mediæval writers who are not usually troubled by geologists. Prof. Wiltshire considers that there is evidence to show that ignition of coal, which had been selected as hut-making material with the help of palæolithic and neolithic implements, occurred and probably accidentally; the mineral not having been selected for its now well-known qualities. Nevertheless, he admits that "the general non-employment of the coals and lignites, in the stone and bronze ages, is well evidenced by the absence of allusion to their use, both in myths and traditions of that date and in the manuscripts which followed not long after." Noticing the silence of Homer on the use of coal, the author very properly places the Levitical coals and those of the Gospels amongst charcoals derived from wood, and he shows that the "carbo" of Pliny and the "anthrax" of Theophrastes were identical. Searching over the dreary pages of this last-named author, Prof. Wiltshire shows that this Greek first noticed and recorded that certain stones were obtained from the ground, and that, broken in pieces, they burn like anthrax (charcoal), and that they come from Liguria and Elis.

The tertiary strata in those localities are lignitic, and true palæozoic coal does not exist there. As years rolled on many coal-like minerals were used, and fancies environed them. Certain it is that during the Roman occupation of Britain, coal was stored and used, for it has been found beneath the ruins of villas in Warwick, Shropshire, Yorkshire, Lancashire, and Durham. The gradual extinction of the Romano-British was followed by hundreds of years of forgetfulness of coal, and then we find the Abbot of Peterborough leasing ground, a part of the rent to be paid in coal, about the time of Alfred. About 1190 the Edinboro' coal-field began to be used, and in 1239 a monopoly of the sale of coal was granted to the Newcastle people.

This interesting lecture is most readable, and well worthy of the accomplished editor of the Palæontographical Society's volumes. P. M. D.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Quarantine in Italy

ALLOW me to say a few words in defence of the prohibitive measures taken by the Italian Government against the introduction into our country of that pest, the phylloxera, and which, though subjected to much unreasonable criticism and selfish opposition here and abroad, have at least been hitherto perfectly successful in protecting our vineyards. Certainly at first sight it would seem that the only necessary measure to be taken ought to be a restriction on the importation of foreign vines, and of the plants (such as fruit-trees) usually cultivated along with them in nursery-grounds, and on whose roots some stray insects might probably occur; and to such a restriction did the Government at first limit itself. But it was soon found out to be quite ineffectual, as it only gave occasion to smuggling on a grand scale, encouraged, I am sorry to say, by certain horticultural firms that did not fear to compromise their respectability by so doing. We all know what ingenious persons smugglers can be; they began introducing the prohibited plants in their leafless state labelled as choicest exotics, to the utter confusion of the Custom House officials, who, being neither naturalists nor scientific men to any degree, were at a loss how to act, until the Government was obliged at last to send the order that no live plant should pass the frontier; a simple rule that anybody can understand, and not to be regretted when one has seen in France and elsewhere thousands of acres of what were once flourishing vineyards blasted by the pest, and has heard of the millions of money lost that way. I shall not mention such petty annoyances as being obliged to leave a bouquet at the Custom House; but surely it is better that our gardens should be deprived of those novelties and rarities that are not obtainable through seeds, rather than run the slightest risk of diminishing one of the principal resources of our impoverished country. Though myself a director of a botanic garden, I own I cannot push my love for flowers to that extent to sacrifice to it much greater interests.

Pisa, February 26 T. CARUEL

Captain Cook's Accuracy

Apropos of your article on the centenary of Capt. Cook's death in NATURE, vol. xix. p. 334, it may be interesting to call attention to his remarkable accuracy in determining the positions of places laid down in his charts. There is a great contrast between his accuracy and the evident carelessness of some more recent navigators. Some years ago when I was sailing in the Pacific we were one day approaching the recorded position of an island which no one on board our vessel had seen. I was conversing with the captain, and asked him whether he expected to find it in its recorded place. To this he replied: "It is sure to be there, for Capt. Cook determined its position; and although I have been now a good many years in the Pacific, I have never yet found him wrong. Had it been the United States Exploring Expedition which determined its place, I should have thought the chances just about equal as to whether it is right or wrong."

There is, unfortunately, too much ground for the remark about the observations of Admiral Wilkes's Expedition. Those who have had opportunities to test the work done by it know that it is often most inaccurate. Quantity of work rather than the quality of it appears to have been the rule with the navigators who conducted that expedition. I believe all Cook's work was worthy of his reputation.

As this is a serious charge to make against such an expedition, it may be well to give some examples to substantiate it. The particulars of the first I take from Findlay's "South Pacific Directory," pp. 633-34. Respecting Vatoa, or Turtle Island, south-east part of the Fiji Archipelago, he says: "A singular mistake crept into the survey by the United States' Expedition. On May 5, 1840, the *Vincennes* 'had a sight of Turtle Island, and determined it to be in lat. 19° 48′ S., long. 178° 33′ W. It has the appearance of a small rounded knoll.' This would seem to be circumstantial, and is further confirmed by a foot-note on the same page. In a subsequent passage the *Porpoise* is said to have determined it to be in lat. 10° 50′ S., long. 178° 37′ 45″ W. 'It was found to be three miles long, by one and a quarter mile wide. The reef extends all around the island, and is from one and a half to two miles wide.'"

If we suppose that in the above 10° is a misprint for 19° there will be only 2′ in lat. and 4′ 45″ in long. difference between the two determinations. But it appears that both of these are about 30′ in error in their longitude. On this Findlay remarks: "This singular variation in longitude from that assigned to it by the great discoverer Cook (178° 0′ W.), or 37′ in error, is startling, because the accuracy of Cook in this instance had been confirmed by other navigators." He then gives an account of an examination of it made by Capt. Worth in H.M.S. *Calypso* in 1848, when he made the island to be "apparently about six miles in length," its centre twenty-nine miles eastward of Wilkes's position, and, instead of the reef from one and a half to two miles wide all around, on the south-west a reef five or six miles wide, with "a large oval coral patch detached from it lying north and south, eight or nine miles in length."

My second example of inaccuracy shall be one in cartography. Some years ago I was about to make a trip into the mountains of Savaii, the largest of the Samoa Islands. Before starting, with Wilkes's chart in my hand, I took a few bearings of points which might serve for comparison when I reached the mountains. I was standing at Tuasivi, a place on the eastern end of the island which may be seen marked in Grundemann's map. To my surprise I found I could see from that place to Tafua point, the south-east extremity of the island, whereas the chart made

the land to project very considerably between the two points. On further examination, I found that, instead of making the land trend inward to a very deep bay at Sapapali'i and Iva, as it does in reality, it had been made to extend seaward in a series of headlands. This error is perpetuated in all the maps I have seen, including Grundemann's, and that published in the *Journal des Museum Godeffroy*, both of which are based on Wilkes's chart.

My third and last example shall be one of a different kind. In 1870 I visited an island north of Samoa known as Quiros or Gente Hermosa. Wilkes' expedition described it as being *without a lagoon*. I found it to be barely four miles in diameter, but with a *deep fresh-water lagoon in its centre about three miles in diameter*. Now as the ring of land around this lagoon is only about one-third of a mile across, I cannot imagine how any members of the expedition could have landed without seeing the water. Such an inaccuracy as this would have been bad enough in the description of an ordinary traveller. It is inexcusable in an expedition specially fitted out for scientific observation.

S. J. WHITMEE

Cook's Collections

IN NATURE, vol. xix. p. 373, a remark of Dr. Hamy, of Paris, is reproduced, concerning "the fate of Cook's collections in being buried in an Austrian museum." It will be of general interest to make known that, what there is in Vienna of ethnographical objects in relation to Cook, consists of 260 numbers, chiefly originating from Cook's third voyage. These objects were bought by order of the Emperor Franz in the year 1806, at the auction of the Parkinson Museum in London (previously Lever Museum), and now form part of the large ethnographical collections, which will be accessible to the public in a few years in the new, nearly completed, Imperial Natural History Museum of Vienna. This museum will become one of the greatest and most complete on the continent, uniting all mineralogical, geological, palæontological, prehistoric, anthropological, ethnographical, zoological, and botanical imperial collections of Vienna under the charge of Prof. Hochstetter. A. B. MEYER

Royal Zoological Museum, Dresden, February 28

Magnetic Storm, May 14, 1878

THERE appears to have been a slight error in my note (vol. xix. p. 148); in the sixth line, it should read 14th instead of 15th.

With this exception the observations are correctly reported, and the period during which the greatest trouble was experienced in working on the Persian Gulf cable covers the time at which the magnetic storm was observed at Stonyhurst to be at its height (vol. xviii. p. 617).

I cannot quite agree with Mr. Preece when he suggests (vol. xix. p. 173) the advisability of recording earth-currents in Webers. Comparatively few of the readers of NATURE would appreciate the magnitude of an earth-current if expressed in those terms, while every one, I think, will understand me when I say that the earth-current passing through the line equalled that which would be produced by a certain number of cells connected to the same circuit.

The systematic observation of earth-currents in different parts of the world is no doubt very desirable, but to be of value it must be regulated and collated by some central authority. I feel convinced that if the Society of Telegraph Engineers invited assistance in this matter, and pointed out what was actually required, the appeal would be very readily responded to.

Kurrachee, February 6 HENRY C. MANCE

Intellect in Brutes

IF Mr. Henslow will read my letter again he will find it distinctly stated that the "several occasions" on which the leakage took place were referred to in connection with the agency of rats only. The plumber informs me that in none of the cases (four or five) was there any sign of injury to the pipe by frost. In the specimen which I have, the rats have made two *ineffectual* attempts to perforate the lead, and have succeeded in two distinct places. Had a frost crack existed, with consequent escape of water, there would have been no necessity to make two fruitless attacks on the pipe elsewhere. The specimen may be seen by any one interested at the office of *The Country*, 170, Strand. Metaphysicians will probably think that Mr. Henslow has stumbled into a quagmire in his discussion of "practical" and "abstract" reasoning. Does he believe that brutes and boys in common have nothing but the faculty of "practical" reason? When a boy finds the value of x in a simple equation, is he not dealing with "abstract" ideas? ARTHUR NICOLS

I AM not opposed to Dr. Darwin's teachings, nor do I care much whether science proves that man is descended from Adam or from some extra clever race of monkeys, so long as the *truth* is established. In regard to the explanation given at p. 365 of the rats eating the pipe to get at the water because they "heard the water trickling," I am inclined to look at the matter in a simple matter-of-fact way, and so feel inclined to think they cut the pipe because it was somehow in their way. Lead and block-tin gas-pipes are found cut in a similar way. Now, are they cut to get at the *gas?* Lead waste-pipes are also often found so cut, both from the outside and inside. I happen to be a practical plumber myself, and have had to deal with rats in many ways, but I scarcely think that "the reasoning power of the rat" in this case has been properly reasoned out.

21, Renfrew Street, Glasgow, March 1 W. P. BUCHAN

I BELIEVE "that the reasoning faculty in man and animals differs in degree only." But I do not think Mr. Nicols' plumber's lead-pipe case (NATURE, vol. xix. p. 365) a well-tested instance of rat sagacity. We have not sufficient proof that the rats gnawed the pipe for the purpose of getting at the water; though, of course, they used the water after having come upon it. It seems more likely that they gnawed the pipe because it obstructed their tunnelling operations; else why did they cut it in two separate places? Mr. Nicols says "a rat will not drink foul water." Neither will I when I can get better, but I am afraid I should need to put up with the foul if I lived in a sewer.

Cambuslang HENRY MUIRHEAD

It is somewhat difficult to understand Mr. Henslow's remarks on the above subject in NATURE, vol. xix. p. 385. He tells us that if the dog that rang the bell to fetch the servant to let him out of a room in which he was shut up, *had not been taught to ring the bell*, "it would have been *abstract reasoning*, but it was only practical." Further on he says that brutes never acquire "abstract reasoning."

The Arctic fox, by Mr. Henslow's own showing, appears to have used "abstract reasoning," because it had never been taught to cut the line attaching the bait to the trigger of the gun before taking the bait (of which I have seen several cases), or to dig a trench in the snow to avoid the shot. Can Mr. Henslow be a sportsman? If so, he ought to know that in the case referred to, to pull the bait downwards *out of the line of fire* was the only safe way for the fox to have acted, so as to get his head out of danger. Had he used what Mr. Henslow calls "abstract reasoning"—which, I presume, means pulling the bait, not the line, to *one side* out of the line of fire, the fox would certainly have been shot, as the bait could not have been moved more than four or five inches from the wooden stake through which the bait-line passes.

If Mr. Henslow really means that the fox should have shown his powers of "abstract reasoning" by going up to the line of fire between the gun and the bait, and then pulled the string until the gun went off, I think the chances of reynard's ever eating the bait would be very small indeed. I have known him do what showed equal or greater intelligence, namely, cut the bait-string, as already mentioned. JOHN RAE

Royal Institution, February 28

MR. HENSLOW, in his letter on this subject, complains that "brute reasoning is always *practical*, but never *abstract*." As an instance of what appears to me abstract reasoning in a dog, I beg to offer the following: A few years ago we had in our possession a terrier gifted with a propensity (probably instructive) for worrying the sheep that were put to graze in a field separated from our house by another field. Coming out of the house one day I observed this dog crossing the latter field, evidently intent upon a little amusement. I called him back, he obeyed; but when he came to a patch of brushwood which hid him from view, he cut straight across the field, under cover of the brushwood, to behind a hedge, and then pursued his course

towards the sheep field. What taught him that he could thus reach his game unobserved? A. J. A.

HERE is an instance of "instinct" which shows, I think, that there is no difference whatever between the reason of animals and that of men.

A mare here had her first foal when she was ten or twelve years old. She was blind of one eye. The result was that she frequently trod upon the foal, or knocked it over when it happened to be on the blind side of her, in consequence of which the foal died when it was three or four weeks old. The next year she had another foal; and we fully expected that the result would be the same. But no; from the day it was born she never moved in the stall without looking round to see where the foal was, and she never trod upon it or injured it in any way. You see that reason did not teach her that she was killing her first foal; her care for the second was the result of memory, imagination, and thought, after the foal was dead and before the next one was born. The only difference that I can see between the reasoning powers of men and of animals, is that the latter is applied only to the very limited sphere of providing for their bodily wants, whereas that of men embraces a vast amount of other objects besides this.

The above limitation does not, I think, apply strictly to domestic animals, dogs especially, which seem to acquire some perceptions beyond mere animal ones.

Hull, February 28 C. W. STRICKLAND

Parhelia

ALLOW me to record the occurrence of parhelia here this morning. The phenomenon lasted about twenty minutes, and was fairly brilliant. No halo was apparent, merely a mock sun on either side of the true one, and the line passing through the three, dipped towards the south at an inclination of 2° to 3° to the horizon. E. W. PRINGLE

Uxbridge, March 4

Unscientific Art

As a specimen of Unscientific Art, let me bring to the notice of your readers a two-page engraving in the last number of the *Illustrated London News*, entitled "Capture of Sirayo's Stronghold."

If there is any truth in the laws of perspective the Zulus flying before the cavalry are indeed "sons of Anak."

Scientific Club, March 2 E. W. PRINGLE

Bees' Stings

IN NATURE, vol. xix. p. 385, a correspondent asks whether the identity of bee-poison with formic acid has yet been determined. Some sixteen years ago I made a few experiments with the poison from wasp-stings, and found, to my astonishment, that it was invariably alkaline instead of acid. A living wasp, duly held in the cavity of a perforated cork, was easily induced to sting a piece of turmeric paper; a brown-red spot immediately appeared. A. H. CHURCH

Cirencester, March 1

A NEW PROCESS IN METALLURGY[1]

LONG before human art acquired the knowledge of metal-making, prehistoric man had learned to make fire of the dry stems and branches of trees; in the charred fragments of half-burnt wood we recognise a form of carbon, the first simple elementary body produced by man from the complex natural bodies with which he was surrounded. In the knowledge of the use of fire, then, was the first dawn of art, particularly of that art which deals with the reduction of simple bodies from compound minerals. To convert metallic compounds into metallic elements is the domain of the metallurgist, and the means by which this is effected constitute the basis of metallurgic art. Carbon was thus a necessity to metallurgy—with the knowledge of fire the world emerged from the stone age. From those early times down to the present day, no fusion has been effected without using carbon, which in the form of wood, coal, or charcoal, has been the substance invariably used by the metallurgist for the production of heat, and to enable him to decompose and to smelt metal-bearing materials.

The new process, however, we are about to describe, has for its object the smelting of metalliferous substances without the employment of carbonaceous fuel. The sulphides of iron, lead, and zinc are known to be combustible substances of almost universal occurrence, and when burnt under favourable conditions give rise to a great evolution of heat. We have calculated the relative temperatures thus produced, from which it appears that the temperature at which iron pyrites (bisulphide of iron) burns in air under the conditions most favourable to the development of a high temperature is over 2,000° C., protosulphide of iron burning at about 2,225° C. Zinc sulphide, or blende, gives a temperature of 1,992° C., and galena 1,863° C.; while calculations made in a similar manner with coal, assuming it to be completely burnt, show the temperature attainable to be 2,787° C. These mineral sulphides, which are therefore natural and almost inexhaustible sources of heat and energy, can under certain circumstances be burnt more economically than their heat-giving equivalent of coal.

The best means, however, of utilising this heat-producing property of metallic sulphides is not so apparent as would appear at first sight. Only iron pyrites is sufficiently combustible at a low temperature to burn in the open air, the mass being raised to the temperature at which the oxidation takes place solely by the union of the sulphur and iron with aerial oxygen. In Spain this is carried on in vast heaps of hundreds of thousands of tons, and the operation extends over many months. The oxide of iron that remains is typical of those mineral substances which, once burned in the primeval operations of nature, gave up their stores of heat and force, and became, as it were, inert bodies.

Going back now to the combustion of carbon, it is well known that it burns at widely varying temperatures, as, for example, in our bodies, in a common coal fire, or in a powerful furnace. A great deal of attention and thought has been spent upon the subject of the economy of carbonaceous fuel, and great advances have been made in this direction, yet the expenditure of coal or coke necessary, say, to melt a given quantity of metal, still far exceeds the theoretical limit. The main causes of this discrepancy may be accounted for as follows:—(1) That only a fractional part of the oxygen of the air passed into the furnace acts upon the material to be burnt. (2) That the oxygen is not brought in contact with the combustible matter with sufficient rapidity to attain the necessary temperature for the operation. (3) That gases pass off hot and unburnt; these are now, however, frequently utilised.

There is one metallurgical operation in which the first two sources of loss are perfectly avoided—namely, by blowing air through molten crude iron, as in the Bessemer operation, where, by the burning of small quantities of carbon and silicon contained in the crude iron a very high temperature is attained, which is not the case in the process of puddling, where the oxidation is spread over a considerable period of time, although the same constituents are frequently burnt in similar proportions. But even in the Bessemer process the carbon is only half burned, and a large amount of heat escapes with the carbonic oxide and nitrogen. When, however, we blow thin streams of air through molten sulphide of iron lying upon a tuyère hearth, a high temperature is produced by the perfect combustion which ensues in the midst of the sulphides, and no unburnt gases excepting sulphur vapour escape from the surface of the molten mass. Hot nitrogen and sulphurous acid being the only gaseous products

[1] A paper with full details of the process was read by John Hollway at the Society of Arts on February 12, 1879; Prof. H. E. Roscoe, F.R.S., in the chair.

of the operation (excepting the small quantities of hydrogen from the aqueous vapour of the air), these may be caused to act upon iron pyrites and other mineral matter. When pyrites is thus heated, an atom of sulphur held in feeble combination is in great part expelled, and thus is obtained protosulphide of iron, with which the operation commences, and which can exist in the molten state. Sulphide of zinc thrown into this bath of molten sulphide is converted into oxide: the sulphides of copper, nickel, and silver do not burn at all so long as sulphide of iron is present, and, accordingly, if oxides, silicates, or carbonates of these latter metals are introduced into the molten sulphide of iron, the iron present will take away the oxygen with which the metals are combined and concentrate them into a regulus of sulphides. But the question then arises, How, after fractional decomposition by oxidation, we can separate the sulphides from the oxides? This is accomplished by the addition of siliceous matter introduced into the furnace with the charge of sulphides, so that in the manner explained are obtained from crude materials five principal classes of products, viz.:—(1) sulphur; (2) sublimates of volatile sulphides and oxides; (3) a slag of silicates of certain more oxidizable metals, principally iron; (4) regulus containing the nickel, copper, and silver; (5) sulphurous acid and nitrogen. Under certain circumstances a sixth class of products may be obtained consisting of the metals copper and lead. Thus, when the sulphides of iron and copper present in the bath are treated continuously with the blast of air without the addition of combustible sulphides, a point at length arrives when the whole of the iron present is oxidised, and the regulus in the bath consists of subsulphide of copper. If now a limited supply of air is introduced, the copper is reduced to the metallic state, with the evolution of sulphurous acid. Further experience in the matter may lead to the adoption of this continuation of the process. Again, sulphide of lead present in the bath may be caused to yield metallic lead by partial oxidation. The sulphurous acid can be made into sulphuric acid in chambers or condensed to the liquid state. Thus we have in this new process a metallurgical operation, the necessary heat for the decomposition and fusion being entirely obtained by the combustion of the iron and sulphur contained in the materials operated on.

Some large experiments have been made in order to prove the more important points here enunciated. They are all to be found described in the paper upon the subject in the *Journal* of the Society of Arts, dated February 14 and 21, 1879. A brief record of some of the phenomena witnessed at the February experiments at Penistone may not be uninteresting. At seven in the morning on February 12 last a small party of gentlemen arrived at Messrs. Cammell & Co.'s Penistone Steel Works, in order to see the operation from its very commencement. Two Bessemer converters were ready for the experiments; one of these was charged at 10 A.M. with some molten protosulphide of iron (made by fusing some pyrites in a cupola), and a blast of air was driven through the tuyères. Lumps of sandstone were continuously thrown in together with cupreous pyrites. A flame of the burning vapour of sulphur expelled from the pyrites passed from the converter mouth to the chimney shaft; it was from 6 to 10 feet long, blue at the edges and greenish in the body of the flame. About noon this experiment broke down through an accident, after which the product was taken out. An experiment was then commenced by setting fire to some sulphide of iron by means of about 2 cwt. of coal thrown into the vessel to start the combustion; pyrites and sandstone were then thrown in, in lumps, which rapidly melted, this being continued until midnight (over eight hours). The molten mass in the vessel remaining perfectly liquid, was from time to time partially poured out to make room for the addition of further similar materials. During the whole of the eight hours not an ounce of coal was used, the converter being "fed with stones," and "vomiting forth fire and brimstone," as a gentleman present graphically expressed it. In this latter experiment about eighteen tons of raw pyrites was thus treated, and over four tons of sulphur was distilled and afterwards burnt. More than half a million cubic feet of sulphurous acid and nitrogen left the mouth of the converter at a high temperature, taking away with them a considerable fraction of the heat produced by the oxidation. This was very unfavourable to the success of the experiment, as will be readily understood when this great loss of heat is taken into account. With a suitable plant the heated gases would be utilized to drive off sulphur from pyrites, so as to produce the molten protosulphide required to continue the operation. Heat is not only obtained by the oxidation of the metallic sulphides, but also by the oxidation of iron protoxide to peroxide when the contents of the vessel are over-blown. In an experiment made in July last the oxidation was thus purposely continued. "As soon as the subsulphide of copper began to burn a splendid emerald green flame suddenly appeared, lasting about a minute, and all the lines except those of copper and sodium left the spectrum. During the last few minutes of the blow the mouth of the converter was dull and without flame."

Some of the products of these experiments were shown at the Society of Arts; they consisted of crystalline masses of ferrous silicate and blocks of 50 per cent. copper regulus. No sulphur was collected, it being impossible to do so with Bessemer plant, which, in actual operations, will not be used for the process. These experiments, however, enabled those present to witness, in the course of a few hours, the principal effects produced. "A remarkable spectrum was obtained from the burning sulphur vapour; viewed through a small direct vision spectroscope, many absorption bands were seen occurring at apparently regular intervals from the red to the violet. The lines of sodium, lithium, and thallium were recognizable, but the majority of the lines are of (as yet) unknown origin, though they are the most important, since the changes furnish indications of the progress of the chemical changes taking place in the vessel. The lithium was, probably, derived from the sand introduced with the pyrites."

The process is peculiarly suitable—(1) For the treatment of metalliferous substances which cannot be advantageously utilised by other processes. For the extraction of sulphur by distillation, and simultaneously for the concentration and separation of copper, silver, and nickel from such materials in the form of a metallic regulus; while lead, zinc, arsenic, &c., accrue in the sublimates. (2) For the treatment of cupreous pyrites, large quantities of which exist in many parts of the world where fuel is scarce, and where the present mode of treatment by the cementation (wet) process involves not only the loss of vast quantities of sulphur, which is burnt to sulphurous acid, but causes the destruction of all vegetation within its influence. For example—About one million tons of pyrites, too poor in copper to pay for shipment to the United Kingdom, are annually treated in Spain by the cementation process. Such ores thus treated, containing 1½ per cent. of copper, leave only a small profit, whereas it is calculated that similar ores by this new process will yield a profit more than five times as great. (3) For the treatment of copper and nickel ores, so as to produce a concentrated regulus without employing carbonaceous fuel.

It is therefore obvious that this process will effect a great revolution in the treatment of metallic sulphides, such as iron, cupreous and nickeliferous pyrites, also copper and nickel ores and the refuse gangue of mining operations, which can thus be smelted without the employment of carbonaceous fuel, the necessary heat being obtained by the oxidation of the metallic sulphides.

ON THE FREEZING OF LAKES[1]

IN pursuance of investigations, now extending over some years, into the natural conditions of our seas and lakes, I took advantage of the recent frost to make some thermometric observations in fresh-water lakes covered with ice.

Most of the observations were made with one of Negretti and Zambra's "half-turn" deep sea thermometers, which proved to be a useful instrument for this species of inquiry. It was necessary however to fit it with a suitable inverting contrivance, as the apparatus supplied for this purpose by the makers is quite useless. When this thermometer was accidentally disabled, thermometers on the Millar-Casella type with certain improvements introduced by myself were used.

Observations were made in Linlithgow Loch at different dates, and in Loch Lomond on January 28 and 29. The results are given in the accompanying tables.

TABLE I.—*Loch Lomond*

Depth. Feet.	Temperature, Fahrenheit, at Station.			
	No. 1.	No. 2.	No. 3.	No. 4.
3	33·00	33·50	33·60	33·70
6	33·50	33·70	33·70	33·80
Bottom 10	—	—	33·80	—
12	33·70	33·80	—	—
18	33·95	33·95	—	33·80
24	34·05	33·95	—	—
Bottom 27	—	33·95	—	—
30	34·15	—	—	33·95
36	34·35	—	—	34·35
42	34·60	—	—	34·55
48	35·20	—	—	35·05
Bottom 51	—	—	—	35·05
54	35·45	—	—	—
60	36·20	—	—	—
Bottom 65	36·30	—	—	—
Mean ...	34·46	33·74	—	34·05

TABLE II.—*Linlithgow Loch*

Depth. Feet.	Temperature, Fahrenheit, at Station.					
	No. 1.	No. 2.	No. 3.	No. 4.	No. 6.	No. 7.
3	34·90	—	—	35·90	36·00	36·00
6	35·25	36·10	36·00	36·30	36·60	36·80
12	37·15	36·80	36·85	36·80	37·35	37·50
Bottom 16	—	—	37·40	—	—	—
Mud 16	—	—	37·80	—	—	—
Bottom 16½	38·50	—	—	—	—	—
18	—	36·95	—	36·90	37·35	37·80
21	—	—	—	—	—	37·80
24	—	37·30	—	37·30	37·50	38·15
30	—	37·40	—	37·40	37·90	38·30
36	—	37·60	—	37·70	38·45	39·00
42	—	—	—	38·40	39·80	40·70
44	—	38·60	—	—	—	—
45	—	—	—	—	—	42·00
Mud 46	—	—	—	39·85	—	—
Mud 47	—	39·75	—	—	—	—
Mud 48	—	—	—	—	41·70	{42·05 42·00
Mean ...	—	—	—	37·22	37·83	38·28

[1] Substance of two papers read before the Royal Society of Edinburgh on January 20 and February 17, 1879.

Had the freezing of the loch taken place according to the commonly received idea, that is, had its waters been first reduced uniformly throughout its depth to the temperature at which the density of water is a maximum, and the surface layer then cooled further until a covering of ice was formed, we should have expected to have found the *remains* of this uniform temperature on examining the water after a firm coating of ice had formed. Distilled water reaches its maximum density at 39·2° Fahr., and I naturally expected to meet with a considerable stratum of water at or near this temperature. Both in Linlithgow Loch and in Loch Lomond there was a tendency to uniformity in the temperature of the water, but in Linlithgow this temperature was approximately 37° F. and in Loch Lomond 34° F. A single glance at the curves of the observations in these two lakes shows that they could never have been developed, if at the time of the formation of the first coating of ice the bulk of the water had been at a uniform temperature of 39·2° F.

In order to explain the existence of this unexpectedly low temperature, I at first imagined that there might be sufficient saline matter dissolved in the water to lower its temperature of maximum density. The presence of five parts of common salt in one thousand parts of water would have sufficed to lower this temperature to about 37°, and as the water of Linlithgow Loch was otherwise excessively foul, it appeared at first sight to be a likely explanation. It was not however verified by experiment. Although possessing a most offensive odour, the water was remarkably free from saline ingredients, and when its change of volume at low temperatures was compared with that of distilled water in the same dilatometer no difference could be detected. Seeing then that the temperature of maximum density was the same as that of distilled water, it was evident that, before being covered with ice, the whole of the water had been cooled down much below that temperature, and that this effect had been produced in a still more marked manner in Loch Lomond.

Let us consider what would be likely to take place during the cooling and freezing of a lake such as the frozen part of Loch Lomond. The water would be cooled down gradually by radiation from the surface, and we may admit that at some date, probably early in December, the whole water from surface to bottom would have a sensibly uniform temperature of 39·2° F. I believe that even in a very small lake there would be no date when the whole of the water would be uniformly at the temperature of maximum density, but it is a condition to which it would approximate in a greater or less degree, according to local circumstances. As the cold continued, circulation would be completely stopped, and cooling would be confined to the surface-layer, supposing the climate of the surface to be absolutely identical all over the surface of the lake. It is impossible that this condition can be fulfilled for more than an instant of time, for it would be disturbed by the slightest movement of the atmosphere. As a matter of fact there is great diversity of climates even at points close to each other, causing among other effects great variations in the temperature of the surface water. Did lakes cool absolutely uniformly throughout their whole extent, there would be no reason why ice should begin to form in one part more than another, and the ice would begin to form at one and the same moment all over the lake, which is contrary to experience.

Let A B C (Fig. 1) represent the bed of a lake in section, D E the surface of the water. At the date when the water has approximately the uniform temperature 39·2° F. D E will represent the isothermal of 39·2. Now let the cooling go on and let the first ice appear, as it naturally would, at the edge. Let E F represent the first piece of ice, which for simplicity's sake we may suppose to have been formed suddenly, and let us consider the effect of its

presence. This effect would be expressed graphically by the dipping of the isothermal of 39·2, as at G, and the generation of those of temperatures intermediate between it and 32° F. This alteration in the temperature means also an alteration in the density; and if we consider a vertical section through the ice at H K and through the middle of the lake at L B we shall find the mean density at L B greater than at H K, and the result would be the production of convection currents. What takes place at E would take place on the other side at A also, and we should have a system of circulation which in broad outline would consist of surface currents from the sides towards the middle, and under currents from the middle towards the sides, somewhat after the manner indicated in Fig. 2. The length of time that these currents would continue to flow before the lake was covered over with ice would depend on a number of local circumstances. The shape, size, and position of the lake would have much influence, and also the severity of the frost. However low the temperature of the air, the strength of the currents would always diminish as the water got cooled down, for the lowest available temperature is 32° and the highest 39·2°. Hence the convection currents would be the strongest at the first formation of the ice, and would gradually, and at an increasing rate, get weaker as the general temperature of the water got lower. When the whole of the water was cooled to 32° they would stop altogether.

It is therefore certain that in the water of a frozen lake we must find a tolerably uniform temperature, and this temperature must lie between 39·2° and 32°. In order that either of these extreme temperatures should

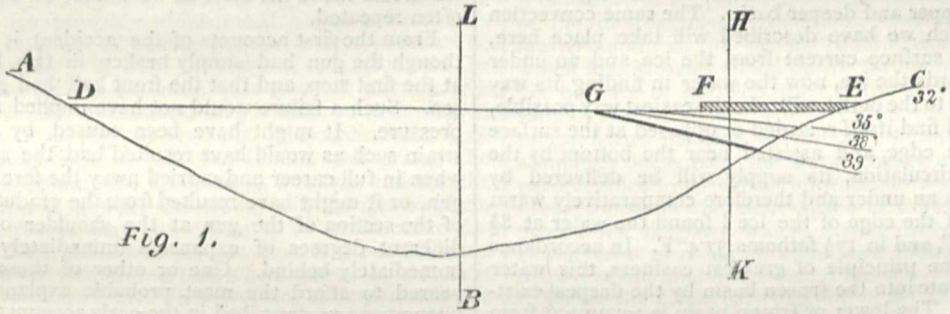

Fig. 1.

prevail, the weather would require to be of a very exceptional character. Admitting that the water had been cooled to a uniform temperature of 39·2°, this temperature could be *fixed* only by a sudden frost of extraordinary and probably unknown intensity. As the convection currents become weaker the more nearly the temperature of the water approaches 32° it would require the least possible frost during an infinite winter to reduce the temperature of the water to 32° before it was covered with ice. The uniform temperature of 32° however could be produced in another way, namely by the cooling of the water after it was covered with ice. This condition is probably not uncommon in shallow lakes in very cold climates.

In general, in climates such as our own, an intermediate temperature would prevail. In the Balloch basin of Loch Lomond this temperature was found to be about 33·9° F. In Linlithgow Loch it was much higher, about 37° F. The lake will remain open with an ice-fringe along the side as long as the water leaves the ice-edge with sufficient velocity to mix with the warmer water off shore before freezing under the influence of surface radiation. As soon however as this velocity is reduced so far as to enable the frost to overtake the water as it leaves the ice-edge before mixing with the warmer water the propagation of ice from the fringe out into the middle of the lake will take place with great rapidity, and a single night will often be sufficient to cover a large lake.

From the moment of the formation of the complete ice covering, the water is subjected to a uniform climate, its surface being everywhere in contact with ice; and it is only under these conditions that the whole of the lake can be said to be exposed to an identical climate.

Hence we see that, even admitting that a uniform tempe-

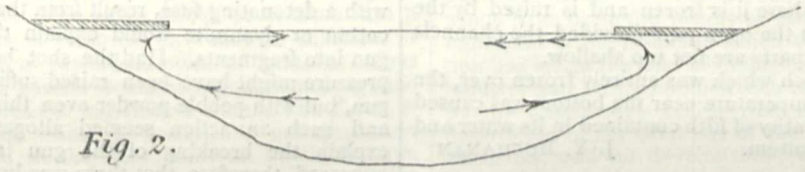

Fig. 2.

rature of 39·2° had previously existed, the whole of the water would be very considerably cooled down before it could be covered with ice, and the extent of this cooling would depend on local circumstances of position and climate, so that the final temperature of the water would be different for different lakes in the same winter, and for the same lake in different winters. The body of the water of a lake would be cooled more when it has been frozen by a moderate and comparatively long continued frost, than when the ice has been frozen quickly by very severe frost. For the more severe the frost the sooner will it be able to overtake the water leaving the ice fringe; in other words, the stronger will be the current which it will be able to arrest, and the greater the *head* which it will be able to stem. But the head which causes the current, is caused by the higher temperature of the open water as compared with that under the ice. Hence the more severe the frost, the higher will be the temperature which it will be able to fix. Let us now consider the causes which would tend to alter the temperature fixed by the ice covering.

In the first place there is alteration in the thickness of the ice and conduction from it downwards. The effect so produced would be concentrated in the surface layer, and its nature can be easily imagined.

In a large lake like Loch Lomond there is, even in severe weather, a considerable amount of change of water going on. The river Leven, which leaves it at Balloch, is navigable for small vessels, and a number of not inconsiderable streams fall in at different parts of the loch. The ice extended from the lower end at Balloch up to Luss, where it terminated in a miniature cliff which swept in a curve from the Dumbartonshire shore to the island of Inchlonaig and thence in another curve to the Stirlingshire shore. It is easy to see that the streams which fall

into the lake in its lower part when it is covered with ice, must supply water at 32° F; for even if it were at a higher temperature while forming part of the stream, it would, by impinging on the edge of the lake ice, be cooled down before being able to mix with its waters. It would thus enter the lake at 32° and would spread itself out immediately under the ice, and its effect on the temperature of the water would be similar to that produced by the thickening of the ice and conduction from it.

The excess of water which falls into the upper and open part of the lake must also find its way under the ice to the outlet. In order to estimate its effect, we must consider the conditions obtaining at the terminal edge of the ice stretching across the lake. We have already discussed what takes place when the first ice fringe forms at the sides of a lake, and we may look on the ice covering the lower and shallower part of the lake, as the fringe on that side of the upper and deeper basin. The same convection currents which we have described will take place here, giving us a surface current from the ice, and an under current towards the ice, now the water in finding its way under the ice to the outlet, will take the easiest way possible, and as it will find itself retarded or opposed at the surface near the ice edge, and assisted near the bottom by the convection circulation, its supply will be delivered by preference as an under and therefore comparatively warm current. Off the edge of the ice I found the water at 8½ fathoms 37·2°, and in 17½ fathoms 37·4° F. In accordance with the same principle of greatest easiness, this water would penetrate into the frozen basin by the deepest existing channel. The lower or frozen basin is separated from the upper and open one by a remarkable chain of islands separated from each other by channels everywhere less than there, and indeed hardly anywere more than two fathoms deep. The two channels however next the main land are each five fathoms deep, and it is through them that the bulk of the water finds its way. This was shown in a very singular way by the existence of a space of open water stretching from the main land to the nearest island over the shallowest part of the channel on the Dumbartonshire shore, there being thick strong ice over the deep water on both sides. In its passage over the ridge which rises very steeply, the warm water is thrown up near the surface and its supply is sufficient not only to preserve this space of open water, but also to raise the temperature of all the water of a depth greater than five fathoms in the lower basin.

In the case then of a lake only partially frozen, the temperature of the water under the ice is lowered by the drainage entering where it is frozen and is raised by the water supplied from the open part provided the channels connecting the two parts are not too shallow.

In Linlithgow Loch which was entirely frozen over, the very great rise of temperature near the bottom was caused by the immense quantity of filth contained in its water and in the mud at the bottom. J. Y. BUCHANAN

ON THE BURSTING OF THE GUN ON BOARD THE THUNDERER [1]

IN the interval which elapsed between the bursting of the gun and the report of the Committee much thought and some trouble has been expended in divining the possible causes which might, under one set of circumstances or another, have led to such a result. It now appears, however, that, different as have been the various suggestions, they all resembled each other in one particular, namely, that they were all wrong.

It is to be hoped, however, that all the ingenuity that has been expended will not have been thrown away, and that some improvement may result from the pointing out of such numerous defects. That in some respects, such as the increasing twist and the sudden steps or shoulders on the outside of the gun, the present system is defective, is shown quite apart from the recent accident; and although it now appears that the moving forward of the shot as the rammer was withdrawn had probably nothing to do with this accident, it cannot be considered satisfactory that this moving forward should be so much the rule as it is shown to have been in the experiments recently undertaken.

Although at first sight it may appear that the fact of the gun having been loaded with two charges of powder and two shot is amply sufficient to explain the bursting, it may not be useless to examine somewhat closely into what would result under such circumstances. The bursting of a 38-ton wrought-iron gun is an experiment of which we should make the most as we cannot expect to have it often repeated.

From the first accounts of the accident it appeared as though the gun had simply broken in two, like a carrot, at the first step, and that the front half had gone into the sea. Such a failure would not have implied an excess of pressure. It might have been caused by a great end strain such as would have resulted had the shot jammed when in full career and carried away the fore part of the gun, or it might have resulted from the gradual weakening of the section of the gun at the shoulder owing to the different degrees of expansion immediately before and immediately behind. One or other of these causes appeared to afford the most probable explanation of the phenomena as described in the early accounts. In various subsequent reports, however, it was stated that fragments of the fore part of the gun were blown about in all directions. So that the gun, instead of having simply broken in two, must have burst like a shell in front of the first shoulder. This fact placed the phenomena in an altogether different light. The explosive bursting of the zone of the gun into fragments implied an enormous excess of pressure at this point of the gun.

In order to cause the tube of the gun to burst longitudinally at all would require several times the normal pressure, and the breaking up of the wrought-iron tube into fragments would show that the force was largely in excess of what was necessary to burst it.

After seeing these reports it appeared certain that the gun had been subjected, at the point of rupture, to a pressure enormously excessive, and the question became whence could such a pressure have arisen? To me it appeared that nothing short of such an action as might, with a detonating fuse, result from the explosion of gun-cotton or dynamite would explain the breaking of the gun into fragments. Had the shot become jammed the pressure might have been raised sufficiently to burst the gun, but with pebble powder even this seemed doubtful, and such an action seemed altogether inadequate to explain the breaking of the gun into fragments. It appeared, therefore, that there was but one conclusion to be drawn—there had been something abnormal in the loading. Had the gun been loaded with small grained powder, gun-cotton, or dynamite, instead of pebble powder, such a result might have been produced; but then, the gun would, if it had burst, have burst at the breach unless the shot had slipped forward, and that there should have been two accidents appeared highly improbable. Besides, it was necessary to consider what sort of a mistake was most likely to have occurred; and the only possible mistake that could have been made on the spot appeared to be that of double loading.

The fact that if two complete charges were put into the gun, the powder of the second charge would be directly beneath the point of rupture appeared in favour of this the easiest mistake. But would, supposing the powder to have been pebble powder, the pressure from the two charges have been sufficient to cause the result? At first

[1] Read before the Lit. and Phil. Society of Manchester on February 18, by Prof. Osborne Reynolds, F.R.S., Professor of Engineering, Owens College, Manchester.

it seemed to me that even supposing that the second charge had been ignited by the first, which was doubtful, this would not explain the suddenness or magnitude of the pressure. But on further consideration it appeared certain that the second charge would not be ignited by the fire from the first; and it then became clear that in this very fact we should have an amply sufficient explanation of the excessive pressure.

My object in writing this paper is to point out the probability of this explanation, and so, if possible, to induce the authorities to test it. It occurred to me several days before the report of the Committee appeared, and in spite of the improbability of such a mistake as double loading, I could not shake off the conviction that it afforded the true explanation. As I have pointed out, the blowing into fragments of a wrought-iron tube implied an explosive action such as might result from gun-cotton or dynamite, but which could not be produced by the slow burning of pebble powder. The point to be explained, then, is how the second charge could be brought into such a condition that it would explode like gun-cotton. To understand this, it must be remembered that in the usual way the grains of gunpowder burn from their outside only, so that the thicker the grains the longer will be the time occupied in burning, and for the same weight of powder the slower will the gas be given off. The reason why gun-cotton is so much more destructive than gunpowder is not that it gives off more gas weight for weight, but that when ignited by a flash it burns so much quicker. If, therefore, by any means the whole mass of gunpowder could be heated up to the firing point at the same instant, so that the grains fired simultaneously inside as well as out, the action of the powder would be as quick or quicker than the gun-cotton. And, still further, if besides being heated the powder was compressed into a fraction of the space it usually occupies, the gases so confined would be capable of a still greater pressure.

Now if the after cartridge were fired and the forward cartridge were not ignited by the flash, and considering the length and fit of the shot, it could hardly have been so ignited, then the after shot would be driven forward closing on to the forward shot and compressing the powder between until the pressure on the forward shot was at least half as great as the pressure of the gases behind the after shot, which would be between ten and twenty tons on the square inch. Thus the powder would be subjected to a squeeze between the two shot such as would result from a blow. It would be compressed to a fraction of its former volume. The cubes would be crushed into a cake and the work of compression would be sufficient to heat the powder far beyond its point of ignition. Thus the entire mass of powder would be simultaneously ignited in a highly compressed and heated state. The force of such an explosion would be practically unlimited and would be located at the very point at which the gun burst. Hence in such an action we have ample cause for the effect produced.

But it will be asked why does not the same thing happen when a rifle is doubly loaded? It is said that in that case the second cartridge is generally blown out before it ignites, and this may be so, for in the rifle the intensity of the pressure of the gas on the shot can never exceed above a twentieth part of what it is in the 12-inch gun, and hence in the case of the rifle the pressure may well be insufficient to ignite the powder between the shot.

This view of the action resulting from the firing of powder by percussion appears to me to be one which it would be well worth while to test, for if proved it would completely re-establish confidence in the strength of the guns, which has been somewhat rudely shaken.

Let a 12-inch gun be loaded with a double charge of powder and a double charge of shot, or a shot of double weight, and fired. If, as is probable, the gun does not burst, confidence in the gun will be re-established. Then let it be loaded twice over with the powder between the shot so as to ascertain whether the action of the powder when fired by percussion would not produce an effect similar to that which we are here considering. The destruction of one gun for the purpose of establishing confidence in all the rest would not seem to be an unworthy sacrifice.

MOSELEY'S NATURALIST ON THE "CHALLENGER"[1]

THIS is certainly the most interesting and suggestive book, descriptive of a naturalist's travels, which has been published since Mr. Darwin's "Journal of Researches" appeared, more than forty years ago. That it is worthy to be placed alongside that delightful record of the impressions, speculations, and reflections of a master-mind, is, we do not doubt, the highest praise which Mr. Moseley would desire for his book, and we do not hesitate to say that such praise is its desert. The same argus-like power of observation, the same readiness to appreciate the true interest and significance of every seemingly little fact, the same energy and indomitable perseverance in gathering information and material from every source in the short space of time at the circumnavigator's disposal which distinguished Mr. Darwin, characterise also his disciple and follower in many a distant ocean land and tropical forest.

Before the *Challenger* expedition set sail, Mr. Moseley was known as an accomplished biologist, trained in the laboratories of Stricker, of Vienna, and of Ludwig, of Leipzig. He had taken part in the eclipse expedition to Ceylon, and besides making valuable spectroscopic observations on the sun, had found time when there to study and collect specimens of the land Planarian Worms, the structure of which was the subject of a memoir by him in the *Philosophical Transactions* (published after the *Challenger* had left in 1874) which threw altogether new light on such important matters as the nature of metameric segmentation and the origin of the blood-lymph space, cœlom, or body-cavity of higher organisms generally.

During the *Challenger* expedition, and since its return in 1876 (when he was by special statute elected to a "research" fellowship by the members of his old college of Exeter, in Oxford), Mr. Moseley has, apart from this volume and its varied contents, produced a series of original memoirs published chiefly by the learned societies of London, which have been the means of making known the most important of the results to which the *Challenger* expedition has led in the field of biological science. It is to his industry and skill, combined with the opportunity afforded by the *Challenger's* cruise, that we owe the thorough description of the anatomy of the worm-like land-living Peripatus, and its development, studied by him at the Cape of Good Hope (*Philosophical Transactions*, 1874), whereby a totally new light is thrown upon the relationships of the great group of Hexapodous and Myriapodous insects, and the origin of tracheæ; to him we are indebted for the discovery and description of the most remarkable among the many pelagic or surface animals taken by the *Challenger* on the high seas, the transparent Pelagonemertes (*Annals* and *Mag. Nat. Hist.*, 1875), as well as for the detection of the only really markedly aberrant form of life dredged by the *Challenger* in deep waters (*Linnean Transactions*, 1878), the Ascidian, Octacnemus bythius. The colouring matters, also, of various marine animals have been studied by him with the spectroscope and the spectra, carefully recorded in the *Quart. Journ Microsc. Sci.* 1877. But of still greater importance and merit was Mr. Moseley's study of corals allied to Millepora and

[1] Notes by a Naturalist on the *Challenger*. By H. N. Moseley, M.A., F.R.S., Fellow of Exeter College, Oxford.

Stylaster, previously unknown (or nearly so) in the living state, although familiar as dry and bleached museum specimens. These, when freshly dredged by the *Challenger*, were treated by Mr. Moseley with those subtle devices known only to trained histologists, and as a result, he has been able to give the full anatomy of the soft parts of these corals, to show that they are compound organisms with variously differentiated "tentacular

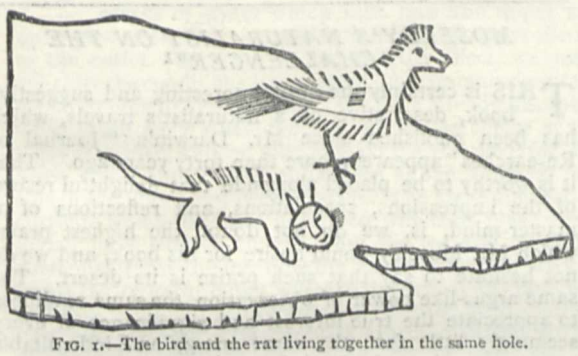

FIG. 1.—The bird and the rat living together in the same hole.

polyps" (dactylozooids) and "mouth polyps" (gastrozooids), and that they constitute a new group of hydroids, and do not belong to the Anthozoa or ordinary coral-producing class of polyps. The results of this elaborate investigation, forming the Croonian lecture for 1878, have been recently published, illustrated with twelve quarto plates by the Royal Society.

Whilst thus actually producing the chief zoological

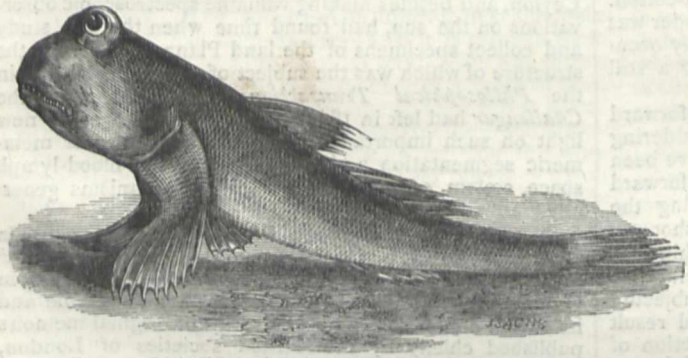

FIG. 2.—*Periophthalmus Kolreuteri* (on land; in the act of leaping).

results of the expedition, Mr. Moseley had specially undertaken the collection of plants, since no professed botanist was attached to the *Challenger*. The *Journal* of the Linnean Society, vols. xiv., xv., xvi., xviii., contain a large series of papers by Professors Oliver and Dickie, the Rev. M. J. Berkeley, and others, on the plants thus collected by Mr. Moseley's own hands on the islands visited by the *Challenger*. Not content with zoology

FIG. 3.—*Peripatus capensis* (natural size).

and botany alone, or rather, one should say, bringing his powers to bear on selected samples of the whole range of biology, Mr. Moseley has published the only anthropological memoir which has come to us from the *Challenger* staff—namely, an elaborate and careful account of an undescribed people—the inhabitants of the Admiralty Islands.

The results of all these researches are lightly sketched and often illustrated by woodcuts in the pages of the present volume, of which, however, they form but a limited portion. A still further development of biological science, namely, sociology—the history of civilisation, of manners, customs, and beliefs, is what the reader will find largely occupying Mr. Moseley's note-book, now published. And indeed, most entertaining and striking notes they are; the sayings and doings, the clothes and the amusements, the religions and the physical surroundings of Polynesians, Malays, Brazilians, Japanese, Chinese, seal-fishers, and English colonists, being set down as they impressed the observant mind of the author, accompanied by most trenchant comparisons and ingenious reflections which are characterised by a singular humour peculiar to him. Mixed with these, according to locality, we have, literally innumerable observations and suggestions with regard to such matters as basaltic columns, antarctic glaciers, flying-fish, fur-seals, phosphorescence, penguins, cockroaches, Kerguelen cabbages, land-crabs, and whales.

A few extracts will suffice to show that whilst Mr. Moseley's note-book will have special value for the professed naturalist, it is also eminently readable, and is likely to obtain great popularity amongst all those who have imaginations sufficiently vivid to allow their possessors to experience that intense form of pleasure which a good book of travels can generate. An enumeration of the titles of the chapters, to begin with, will show something of the distribution of matter in the book.

We have—I. Teneriffe, St. Thomas, Bermuda; II. Azores, Madeira, Cape Verdes; III. St. Paul's Rocks and Fernando do Norhona; IV. Bahia; V. Tristan da Cunha, Inaccessible Island, Nightingale Island; VI. Cape of Good Hope; VII. Prince Edward Island, the Crozet Islands; VIII. Kerguelen's Land; IX. Heard Island; X. Amongst the Southern Ice; XI. Victoria, New South Wales; XII. New Zealand, the Friendly Islands, Matuku Island; XIII. Fiji Islands; XIV. New Hebrides, Cape York, Torres Straits; XV. Aru, Ke, Banda, Amboina; XVI. The Philippine Islands; XVII. China, New Guinea; XVIII. The Admiralty Islands; XIX. Japan, the Sandwich Islands; XX. Tahiti, Juan Fernandez; XXI. Chile, Magellan's Straits, Falkland Islands, Ascension; XXII. Life on the Ocean Surface and in the Deep Sea, Zoology and Botany of the Ship, Conclusion.

Take the following description of a Penguin rookery at Tristan da Cunha (p. 120) as an example of Mr. Moseley's style. "It is impossible to conceive the discomfort of making one's way through a big rookery, haphazard, or 'across country,' as one may say. I crossed the large one here twice afterwards with seamen carrying my basket and vasculum, and afterwards went through a larger rookery still, at Nightingale Island. You plunge into one of the lanes in the tall grass, which at once shuts out the surroundings from your view. You tread on a slimy black damp soil composed of the bird's dung. The stench is overpowering, the yelling of the birds perfectly terrifying; I can call it nothing else. You lose the path, or perhaps are bent from the first on making direct for some spot on the other side of the rookery. In the path only a few droves of penguins, on their way to and from the water are encountered, and these stampede out of your way into the side-alleys. Now you are, the instant you leave the road, on the actual breeding-ground. The nests are placed so thickly that you cannot help treading on eggs and young birds at almost every step. A parent bird sits on each nest with its sharp beak erect and open ready to bite, yelling savagely 'caa, caa, urr, urr,' its red eye gleaming, and its plumes at half-cock, quivering with rage. No sooner are your legs within reach than they

are furiously bitten, often by two or three birds at once, that is, if you have not got on strong leathern gaiters, as on the first occasion of visiting a rookery you probably have not.

"At first you try to avoid the nests, but soon find that impossible: then, maddened almost by the pain, stench, and noise, you have recourse to brutality. Thump, thump goes your stick, and at each blow down goes a bird. Thud, thud, you hear from the men behind as they kick the birds right and left off the nests, and so you go on for a bit, thump and smash, whack, thud, 'caa, caa, urr, urr,' and the path behind you is strewed with the dead, and dying, and bleeding.

"But you make miserably slow progress, and, worried to death, at last resort to the expedient of stampeding as far as your breath will carry you. You put down your head and make a rush through the grass, treading on old and young haphazard, and rushing on before they have time to bite.

"The air is close in the rookery, and the sun hot above, and, out of breath, steaming with perspiration, you come across a mass of rock fallen from the cliff above, and sticking up in the rookery; this you hail as 'a city of refuge.' You hammer off it hurriedly half a dozen penguins who are sunning themselves there, and are on the look-out, and, mounting on the top, take out your handkerchief to wipe away the perspiration and rest awhile, and see in what direction you have been going, how far you have got, and in which direction you are to make the next plunge. Then, when you are refreshed, you make another rush, and so on.

"If you stand quite still, so long as your foot is not actually on the top of a nest of eggs or young, the penguins soon cease biting at you and yelling. I always adopted the stampede method in rookeries, but the men usually preferred to have their revenge, and fought their way every foot. Of course it is horribly cruel thus to kill whole families of innocent birds, but it is absolutely necessary. One must cross the rookeries in order to explore the island at all, and collect the plants or survey the coast from the heights."

Here is an example (p. 213) of the many observations which the book contains on the habits of birds and other animals:—

"An idea of the relations of the various birds to one another in the struggle for existence will be gained from the following incident:—I saw a cormorant rise to the surface of the water, and, lifting its head, make desperate efforts to gorge a small fish which it had caught, evidently knowing its danger, and in a fearful hurry to get it down. Before it could swallow its prey, down came a gull, snatched the fish after a slight struggle, and carried it off to the rocks on the shore. Here a lot of other gulls immediately began to assert their right to a share, when down swooped a skua from aloft, right on to the heap of gulls, seized the fish and swallowed it at once. The shag ought to learn to swallow under water, and the gull to devour its prey at once in the air. The skua is merely a gull which has developed itself by fighting for morsels."

Mr. Moseley has a great deal to say about the structure and natural history of icebergs in the chapter on the southern ice, and has illustrated this part of his book with two coloured plates and numerous woodcuts. The *Challenger* was in some danger here. "As the weather became worse, we were in a rather critical position. We were surrounded by bergs, with the weather so thick with snow, that we could not see much more than a ship's length, and a heavy gale was blowing. The full power of steam available was employed. Once we had a narrow escape of running into a large berg, passing only just about 100 yards to leeward of it by making a stern board, with all the sails aback, and screwing full speed astern at the same time. The deck was covered with frozen powdery snow, and forward was coated with ice from the shipping of seas. On February 28 again there were forty icebergs in sight at noon. It came on to snow thickly at about 4 P.M., and another gale came on. The plan adopted by Capt. Sir G. Nares was to lay down the bearings of the adjacent bergs before the weather became too thick for them to be seen, and then steaming with all the power of the ship against the gale, to hang on as long as possible under the lee of a large iceberg, and, when driven away from that, to steam rapidly across to the lee of another, the position of which was known by the bearings taken. So we went on steaming backwards and forwards through the whole of a thick, dark night."

FIG. 4.—Face of Japanese Actor. (To show the mode of painting the face. From a Japanese Theatrical Picture-book.)

FIG. 5.—Head of figure burnt at Chinese funerals, made of paste-board. (To show the mode of painting the face.)

In warmer climes anthropology occupied, as we have said, much of the traveller's attention. The Tongans interested him by their expressive faces and gestures. A boat full of them was commanded by a noble, degraded from his rank by the missionaries, as a punishment for habitual drunkenness (p. 285).

"The coxswain of the pilot's boat, the ex-member of the nobility, wore, as I have said, a pea-jacket; a photograph was taken of the boat's crew. I could not persuade the coxswain to take off the pea-jacket, in order to make the group uniform [the others were quite naked, except a cloth round the waist]; he would only promise that if he were photographed with the jacket on in the group, he would allow himself to be taken with it off, separately afterwards. The jacket was a thick garment of the usual pilot cloth, fit only for an English winter, but the man evidently regarded it as a mark of distinction and decoration, and a proof that he was coxswain. I had much difficulty in getting a lock of hair from one of the boat's crew, and only succeeded by the help of a missionary, who explained that I did not want it for purposes of witchcraft. The man was also evidently loth to part with a single lock of what was his chief pride. I often, in collecting hairs of various races, subsequently, for scientific purposes, had amusing difficulties to contend with, and I suspect that some of the girls, from whom I got specimens, thought I was desperately in love with them."

Here is a suggestive association of man and the pig (p. 517)—

"Rats live in the mountains [of Tahiti], and climb up and devour the ripe bananas, and the groves of the trees are traversed in all directions by the tracks of wild pigs, which likewise feed on the fruit. It is strange that the pig should run wild and thrive, under such widely different conditions as it does, and should be able to exist equally well on wild plantains in the warm Tahiti, and on penguins and petrels in the chilly Crozets. In this power of adaptation it approaches man."

In his account of his short visit to Hong Kong and Canton, Mr. Moseley has much to say about the habits of the Chinese and their literature, medicines, and amusements. He reproduces several curious woodcuts from a Chinese work on natural history, the "Shan Hoi King." One of these (Fig. 1) represents, according to the description in the margin, "The Bird and the Rat which live together in the same hole. They come from the mountain of the tailed rats and birds in Wai Une, where they may still be seen." "No doubt," Mr. Moseley remarks (p. 431), "the rat is the ground squirrel (*Spermophilus mongolicus*), and the bird must be an owl, which is associated with it, just as is the small ground owl (*Speotyto cunicularia*) of America with the prairie dog and also with the ground squirrel of California, in the holes of which, as familiarly known, it lives. The genus Speotyto is, however, peculiar, as far as is known, to America and the West Indies; and the fact that an owl lives in the holes of the Asiatic ground squirrel is not known to naturalists. Mr. R. Bowdler Sharpe, however, tells me that a small owl, *Carine plumipes*, exists in northern China, which lives in holes in the ground. Possibly this bird has developed the same curious habit of association with a rodent, as has the American ground owl. If so, the fact is very remarkable."

Our second woodcut, borrowed from Mr. Moseley (Fig. 2), represents a fish (*Periophthalmus*) of very strange habits, which, like the land-crabs, though allied to aquatic animals, and irresistibly suggesting to the observer the notion that it is most at home under the water, yet would actually be drowned in all probability were it kept under water for long. Mr. Moseley has chased these queer fish in Ceylon and the Fiji Islands (p. 296). "They are very nimble on land, and difficult to catch. They use their very muscular pectoral fins to spring with, and, when resting on shore, the fore part of their body is raised and supported on these. There seems to be no figure of this very remarkable fish, which shows it at all in the attitude which it assumes when alive. The accompanying woodcut has been drawn from a specimen kindly lent to me by Dr. Günther, and I have put the fish as nearly in the natural position which it assumes when on land, as I can from memory." Space does not allow us to reproduce the excellent account of the Pearly Nautilus which follows here in the chapter on Fiji.

A good figure of Mr. Moseley's *protégé*, Peripatus, is given on p. 159, and is transferred to these pages (Fig. 3). A clear and intelligible account of the points of interest in the anatomy and habits of this caterpillar-like creature is given in the chapter on the Cape, and we read how both the author and von Suhm (one of the three other naturalists of the expedition, the other two being Sir Wyville Thomson and Mr. Murray) hunted high and low for specimens near Cape Town. Von Suhm "was unsuccessful; but I was lucky enough to find a fine specimen first under an old cart-wheel at Wynberg. Immediately that I opened this one I saw its tracheæ, and the fully-formed young within it. Had my colleague lighted on the specimen he would no doubt have made the discovery instead." It was, however, we take leave to assert, in spite of Mr. Moseley's modesty, no chance which brought the Peripatus to his hands, but, simply enough, the unwearying energy and ingenuity which characterised his proceedings throughout the voyage. At the Island of St. Thomas (p. 15) the party "heard of" Peripatus, but did not procure any. In New Zealand (p. 279) we again find mention of Peripatus; this time brought to Mr. Moseley's hands by a local naturalist, Mr. Locke Travers, F.L.S. Another result of Mr. Moseley's exertions at the Cape was his discovery of two specimens of the skull of the excessively rare and curious Ziphioid whale, *Mesoplodon Layardii*.

Tattooing and the use of paint as an ornament in China and Japan are amongst the subjects which Mr. Moseley discusses at length (p. 489), bringing a variety of facts together from his observations of Polynesians, as well as other races. The painting of the face by Chinese and Japanese is not similar to that practised by European ladies. "An even layer of white is put on over the whole face and neck, with the exception in Japan of two or three angular points of natural brown skin, which are left bare at the back of the neck as a contrast. After the face is whitened, a dab of red is rubbed in on the cheeks, below each eye. The lips are then coloured pink with magenta, and in Japan this colour is put on so thickly that it ceases to appear red, but takes on the iridescent metallic green tint of the crystallised aniline colour. In modern Japanese picture-books the lips of girls will sometimes be seen thus represented green. I suppose the idea is that such thick application of paint shows a meritorious disregard of expense. It is curious that the use of aniline colour should have so rapidly spread in China and Japan. In China, at least, such was not to be expected, but it seems to have supplanted the old rouge, and it is sold spread on folding cards, with Chinese characters on them, at Canton and in Japan."

"This form of painting the face seems to be exactly of the same nature as savage-painting, and possibly is a direct continuation of it. It is like the painting of our clowns in pantomimes. In China the faces of men (as opposed to women) seem not to be painted at the present time either on the stage or elsewhere; but in Japan, actors in certain plays are painted on the face with bright streaks of red paint, put on usually on each side of the eyes. The kind of painting is exactly that of savages (Fig. 4). It is a curious fact that this form of painting, surviving in adults on the stage, is still used elsewhere for the decoration of young children. It is quite common to see children on festive occasions, when elaborately dressed by their parents, further adorned with one or two transverse narrow streaks of bright red paint, leading outwards from the outer corners of their eyes, or placed near that position."

"Such a form of painting possibly existed in ancient

times in China. When a man of distinction was buried in China in former times, a certain number of servants were buried with him. Now, figures made of pasteboard and paper, about three feet or so high, are burnt at the funeral service, in small furnaces provided for the purpose in the temples, together with cartloads of similar pasteboard gifts, which are thus sent by the survivors for the use of the dead in the next world. Earthenware figures were similarly buried with great men in old times in Japan.

"The pasteboard heads of these funeral servants and retainers are painted with streaks, some of which are put on in almost exactly the same style at the angles of the eyes as those of modern Japanese actors. It seems a fair conjecture that the streaks on these heads (Fig. 5) are a direct survival of an actual former savage form of painting which was once in vogue in China, probably used to make fighting-men hideous. It is well known that primitive customs survive in connection with funerals all over the world with extreme tenacity. The numerous interesting survivals existing in the case of English funerals are familiar."

In connection with colour and decoration, we must draw the attention of breeders of poultry to the important experiment on sexual selection suggested on p. 373. Mr. Moseley in fact proposes to test the existence of a preference for colour on the part of hen-birds, by variously dyeing and manipulating the colours of two of more cock-birds kept with her.

The last chapter is one of the most interesting in the book, since here Mr. Moseley does not compress his wonderful richness of material into the short space which is necessary where he adopts the method of telling the reader all that he saw and thought about in one locality after another of the long list visited by the *Challenger*. Here he launches out more fully into discussion and gives a summary, intended for the general reader, of the most striking features presented by the life of the ocean surface, of the deep sea, and of the colony of cockroaches, rats, and other animals and plants which established themselves or were introduced on board-ship.

The significance of colour in marine animals is very suggestively treated, and the origin and use of phosphorescence likewise considered in an original manner. He says (p. 590):—

"The light emitted by phosphorescent animals is quite possibly in some instances to be regarded only as an accidental product, and of no use to the animal producing it; although of course, in some cases, it has been turned to account for sexual purposes and may have other uses occasionally. There is no reason why a constant emission of light should be more beneficial than a constant emission of heat, such as takes place in the case of our own bodies, and it is quite conceivable that animals might exist to which obscure heat rays might be visible, and to which men and mammals generally would appear constantly luminous."

The concluding paragraph contains a suggestion which could be carried into effect without expense by the Government, and there can be no question as to the naturalist best fitted to direct such an undertaking. Mr. Moseley says:—

"The urgent necessity of the present day is a scientific circumnavigating expedition which shall visit the least known inhabited islands of the Pacific, and at the same time explore the series of islands and island groups which yet remain almost or entirely unknown as regards their botany and zoology. These promise to yield results of the highest interest, if only the matter be taken in hand in time, before introduced weeds and goats have destroyed their natural vegetation; dogs, cats, and pigs, their animals and their human inhabitants have been swept away, or have had their individuality merged in the onward press of European enterprise. There is still, to the disgrace of British science, even in the Atlantic Ocean, an island, the fauna and the flora of which are as yet absolutely unknown. The past history of the deep sea, of the changes of depression and elevation of its bottom, is to be sought to a large extent in the study of the animals and the plants inhabiting the islands, which rear their summits above its surface. These insular floras and faunas will soon pass away, but the deep-sea animals will very possibly remain unchanged from their present condition long after man has died out."

Besides numerous woodcuts, Mr. Moseley's book is illustrated by two coloured plates of antarctic icebergs, and a track-chart of the world, with contour-colours of the sea-bottom. A very copious and carefully prepared index is appended. Throughout the book the references to literature of all kinds bearing upon the myriad topics touched upon are very abundant, and form one of the most intrinsically valuable features of the work.

E. RAY LANKESTER

METEOROLOGICAL NOTES

FROM the third annual Report of the Forest Meteorological Stations of Germany, being the Report for 1877, we learn that this system of inquiry into the influence of forests on weather and climate now includes fourteen stations scattered over a region extending over 7° of latitude and 5° of longitude, the stations being at heights ranging from 10 to 3,051 feet above the sea. The instruments and observations have been planned on satisfactory and comprehensive principles, and in a few years results eminently *ad rem* may be looked for. In the meantime the thermometric observations point to highly important results. Each station has three sets of thermometers for air temperature, similarly protected—one set in the wood, the second set high up in the crown of a tree, and the third set in an open space outside the wood, while earth thermometers are placed both in the open and in the wood, on the surface of the ground, and at depths of 6, 12, 24, 36, and 48 inches. The results show in every case a lower air temperature inside the wood as compared with the open country outside, the mean difference amounting to 1°·3. As regards the temperature of the surface of the ground, the mean deficiency in the wood shaded by the trees is 2°·5, an amount which gradually diminishes with the depth to 2°·0 at 48 inches, the lowest depth observed. It would be a problem of great interest to ascertain how deep this cooling of the earth's surface extends when it is screened by trees from solar and terrestrial radiation. What are called the "true means" of atmospheric pressure are calculated from the observations at 8 A.M. and 2 P.M., the formula being

$$\frac{\text{VIII.} \times 2 + \text{II.} \times 5}{7}.$$

Since the stations range in height from 10 to 3,051 feet, and otherwise differ in their physical conditions, it is scarcely necessary to point out that the method of reduction adopted is very faulty.

SOME years ago a good deal of writing appeared in the periodical press depreciatory of the climate of Rome on account, as alleged, of the exposure of that city to the pestilential malaria of the Campagna. Many of the opinions then expressed will not bear scrutiny when confronted with the facts of the mortality and health of Rome. It was to counteract these opinions, which obtained wide currency, that a book entitled "The *Times* Newspaper and the Climate of Rome," by S. A. Smith, was recently published. The author has brought to his task the experience of a twenty years' residence, by which he has been enabled to sketch familiarly and with general truthfulness the broad features of its climate in its hygienic rela-

tions; and in addition, strong feelings, we may almost add of animosity, towards the writers whose opinions he sets himself to combat. The result is a readable book, containing much valuable information to those who intend visiting Rome, though occasionally marred by the introduction of hasty writing and hasty feeling. In comparing (p. 151) the mortality from typhoid in London in 1870 with that of Rome in 1876, the deaths in London are stated to have been 2,008, or 10 per cent. higher than the deaths in Rome; whereas the deaths from typhoid in London in 1870 were only 976, giving a mortality from this disease of little more than half that of Rome. Technical knowledge also on occasions fails the author; thus it is strongly asserted (p. 120) that the diurnal fall of temperature takes place almost exclusively between 3 P.M. and sunset, and between 9 or 10 P.M. and sunrise, but the two hours after sunset are those when the temperature is most nearly stationary. The mortality statistics, now published weekly by Cocchi, will soon supply information for a satisfactory handling of various questions which have been raised touching the health of Rome.

THE Missouri (U.S.) Weather Service Report for January last is just received (February 24), from which we learn that at St. Louis the temperature did not rise to freezing from December 11 to January 15; the mean temperature of the first ten days of January was only 9°·0, and that of the whole month 26°·9, or 4°·7 below the average; and at Oregon, in the north-west of the State, the sleighing season ended on January 25, after a continuance of fifty days. The lowest observed temperature was − 24°·0 at Phelps City on the 3rd, and at Columbia on the 4th, and temperatures nearly as low were noted on these days at many other places. The rain- and snow-fall was moderate in amount, being about two inches in the extreme south-east and south-west and along the low country round the mouth of the Missouri, whilst in the north the fall was considerably under an inch of rain and melted snow. The cold of January, 1857, was much more intense than during last month, the mean temperature of that month being only 19°·3, or 12°·3 below the average. It is delightful to note the frank, effective manner in which Director Nipher is bringing about uniformity in his observers' reports; thus, after pointing out that "rainy" or "snowy" days are only those on which the rain or melted snow amounts to at least 0·01 inch, he adds that "this international rule is almost universally disregarded by our observers."

THE meteorological observations made at the Hydrographic Office at Pola during 1878 have been issued, with a full abstract for the year, showing the hourly means of pressure, temperature, and wind-velocity. The most prevalent winds by far are from the quarter of the compass from east-north-east to south-east, these comprising nearly half the winds of the whole year, to which there is to be added a small secondary maximum of west-north-west winds. The wind falls to its daily minimum velocity at 5 to 6 A.M., and rises to the maximum so early as noon, hours all but coincident with the daily maximum and minimum temperature. From the three years' observations now available from Pola, it is seen that in common with sea-side stations of the middle and higher latitudes, the A.M. maximum of pressure occurs later in winter than in summer, in contradiction to inland places where it occurs much earlier. Pola being in latitude 44° 52′ north, and thus within the belt to which Rikatscheff drew attention some time ago, as characterised by the occurrence, or tendency toward the occurrence, of a third maximum of pressure a little after midnight during the cold months of the year, it is interesting to note that four out of the nine individual Decembers, Januarys, and Februarys, show the occurrence of this third maximum, which also appears in the general means of December and January for the three years. The amount of this third maximum is very small, and the evidence yet adduced is not sufficient to determine whether it is a real increase of atmospheric pressure, or merely an apparent increase due to undetected instrumental errors.

OUR ASTRONOMICAL COLUMN

BRORSEN'S COMET.—Notwithstanding the track of this comet at the present appearance is a very favourable one for observation in these latitudes during April and May, the theoretical intensity of light at maximum is much less than that attaching to the first appearance in 1846; indeed, in the middle of April, when it is greatest, it is only half that of the middle of March 1846. The comet in that year was never a conspicuous object in ordinary telescopes; it approached pretty near to the earth, and on March 25 its apparent diameter was about 9′, corresponding to a true diameter of 126,000 miles.

The following positions for part of the present month are reduced to 7h. Greenwich time from Dr. Schulze's ephemeris, which has been calculated for Berlin noon:—

	R.A. h. m. s.	N.P.D. ° ′		R.A. h. m. s.	N.P.D. ° ′
March 10	1 29 4	90 15·4	March 18	1 55 56	82 59·8
,, 12	1 35 39	88 33·0	,, 20	2 2 51	81 0·0
,, 14	1 42 20	86 46·3	,, 22	2 9 50	78 55·8
,, 16	1 49 6	84 55·2	,, 24	2 16 52	76 47·3

The comet will be nearest to the earth (distance = 0·683) on the night of May 3, its position at the time being between 49 and 55 Camelopardi. Between April 14 and June 11 it will not descend below the horizon of Greenwich, attaining its greatest north declination (65° 30′) on May 11, in the head of Ursa Major. The comet was found by Dr. Tempel, as already stated, on January 14, more than a month before the ephemeris by Dr. Schulze commences, and as we remarked in a former note, was thus observed with a much less intensity of light than at any previous opposition. The error of the ephemeris has not yet been published, but it appears not to be large. We shall continue the ephemeris in due course when better advised on this point.

In his report upon the work of the Observatory of Leipsic in 1877, Prof. Bruhns mentions that Herr Harzer a student in that university had, at his request, redetermined the effect of the attraction of Jupiter upon the elements of the comet at the near approach of the two bodies in May, 1842, and with satisfactory results. In 1857 the late Prof. D'Arrest made a first approximation, by the method of the *Mécanique Céleste*, to the orbit which the comet described prior to the great perturbation or on entering the sphere of activity of Jupiter about April 19·5 Berlin time in 1842; the elements at that epoch were found to be as follows (we annex the elements in 1846 at the time of the comet's first discovery for the sake of comparison):

	1842, April 19·5.	1846, Feb. 25·4.
Long. of perihelion	133° 26′·7	116° 28′·2
,, ascending node ...	107° 44′·0	102° 41′·0
Inclination	40° 51′·0	30° 55′·9
Excentricity	0·59275	0·79338
Perihelion distance	1·50130	0·65013
Log. semi-axis major	0·56661	0·49783
Period	7·078 years.	5·581 years.

It will be seen that the perihelion distance before the encounter with Jupiter was much greater than it now is, a sufficient reason, as was pointed out by D'Arrest, for this comet to have been missed, if it had moved in the orbit which was so much changed in 1842.

MINOR PLANETS.—M. Palisa notifies his discovery of No. 192 at Pola on February 17. At 13h. 47m. m.t. its R.A. was 11h. 10m. 20s., and N.P.D., 84° 6′, eleventh magnitude.

Hilda, the most distant of the minor planets, which is

probably in the same region of the sky, has not yet been recovered. The planet which was named *Scylla*, and of which only four observations could be obtained at Pola and Berlin in November, 1875, will probably be difficult to detect again, since the observations, though inadequate to furnish elements with any pretensions to accuracy, sufficiently prove that the inclination of the orbit to the ecliptic must be pretty large. In case any one of our readers should be disposed to examine this point further, we subjoin the four observed positions reduced to longitude and latitude :—

	Greenwich mean time.	Longitude App. Eq.	Latitude North.
		° ′ ″	° ′ ″
1875, November	8·61578 ...	48 5 2 ...	1 58 41
,, ,,	9·42473 ...	47 54 13 ...	2 6 28
,, ,,	22·56605 ...	44 54 44 ...	3 53 18
,, ,,	23·44691 ...	44 43 41 ...	4 0 7

VARIABLE STARS.—Dr. Weiss, Director of the Imperial Observatory at Vienna, announces several new variable stars. One is Lalande 28607, which varies from 7·0 to 8·8 in a period not differing much from four months; this star is further to be noted for its large proper motion, $\Delta\alpha = -0^{s}\cdot080$, $\Delta\delta = -0''\cdot35$. He also confirms variation in the neighbouring double star Lalande 28590, which had been suspected by Struve. Further, the stars in the *Durchmusterung*, +17°, Nos. 2510 and 2511, are found to be variable, the former from 8·8 to 10·0 in rather over eleven months, and the latter, also to the extent of about one magnitude, in a somewhat shorter period, about 9½ months.

M. Ceraski, of the Moscow Observatory, also finds variation in the star, which appears thus in the *Durchmusterung*: mag. 9·2, R.A. 21h. 9m. 25s., Decl. +67° 49′·5.

GEOGRAPHICAL NOTES

THE Council of the Royal Geographical Society have presented a remarkable memorial "to H.M. Commissioners of the University of Oxford, to those of Cambridge, and to the Governing Bodies of either University." The burden of this memorial is that steps ought to be taken for the establishment of professorships of geography in the two universities. The memorial points out forcibly and justly the ignorance of geography in its highest sense, in this country, where it is commonly confounded with mere topography. The Council of the Society, we are pleased to see, show that they possess an adequate conception of the position which geography ought to occupy, and which, indeed, it does occupy in the Universities of Germany, Switzerland, and France. We have often repeated that geography is really the meeting-place of all the sciences, and this is the idea which the Council endeavour to enforce upon the Commissioners and governing bodies of the universities. They show, how, to have an adequate knowledge of geography it is necessary to know something of both the biological and physical sciences, and be able to trace the mutual influence of man and his surroundings. The duties of such a professor as the Council desire to see appointed, the memorial states, would be first, to promote the study of scientific geography, and secondly, to apply geographical knowledge in illustrating and completing such of the recognised university studies as require aid. It is suggested, also, that he might deliver at least one annual discourse on some subject of geographical research. The memorial rightly states that there is no country that can less afford to dispense with geographical knowledge, but we doubt if the number of members of the Geographical Society is any evidence that we have a greater natural interest in the subject than other people. Certainly we ought to have, for our interests are as wide as the world; and as the memorial states, it would not be difficult to cite instances in which these interests have been seriously compromised by a want of geographical knowledge. Thus, that as a nation, we are far behind, both in our conception and in our knowledge of geography in its highest sense there can be no doubt, but whether this state of things is to be remedied by the founding of professorships of geography at Oxford and Cambridge is another question, which at present we cannot discuss. It appears to us at first sight as if it were beginning at the wrong end. Moreover, is not geography in its highest sense really only a branch of physiography, and would not the want in our university education be most effectually met by a professorship, or perhaps a lectureship, on that subject? At all events we are grateful to the Geographical Society for drawing attention to the importance and comprehensiveness which geography has assumed on the Continent, and to the lamentable want of interest in the subject which exists in this country.

ON the suggestion of the Bishop of Salford a committee has been formed in Manchester for establishing a Society of Commercial Geography. Mr. Armitage, the Bishop of Manchester, Mr. Arthur Arnold, Mr. Hugh Mason, Mr. Slagg, Mr. J. E. Taylor, and others, have joined the committee. We suggested some time ago the utility of forming such societies in our chief commercial centres, and we hope the example of Manchester will soon be followed by our principal seaports. That Manchester stands in need of some education in geographical matters was evidenced by the ignorance of African geography shown at the recent meetings to promote the formation of a railway from Zanzibar to the Lake Region. Similar societies have been found of great service in France. Might it not be well, however, if other towns form similar societies, that some common organisation be formed, and perhaps a common journal be published?

FROM the new Yellow Book of the Chinese Maritime Customs we gather some notes respecting the island of Hainan, the port of which, Kiungchow, has been recently opened to foreign trade. So far it has certainly not proved a commercial Eldorado, but what the real capabilities of the island are it is difficult to judge so long as the greater part remains a *terra incognita* to foreigners. This much, however, may be said in its favour, that it possesses an advantage over many islands of its size, viz., a large navigable river by which access may be gained to the interior, and which partially obviates the necessity for good roads. From the *Kiungchow Record* it appears that gold, silver, copper, tin, and loadstone are found in different parts of the island, but no mention is made of coal. The author of the report we allude to knows that peat exists, and samples of carbonate of copper have been shown him by natives. The number of different kinds of grain and other produce enumerated in the Chinese work referred to as growing in Hainan is surprising, and includes many varieties of rice, millet, Barbadoes millet, wheat, barley, beans, peas, sugar-cane, sesamum, ground-nut, taro, and yam. Of medicines (according to the Chinese pharmacopœia) exported the following are the chief items :—*Ai-fên*, a kind of camphor, obtained from the aborigines and said to be distilled from the leaves of the *Artemisia moxa*, *ho-hsiang*, stalks and leaves of *Betonica officinalis*, bitter cardamoms, cardamoms, the berries of *Abrus precatorius*, the stalks of *Dendrobium ceraia*, and tortoise-shell rind.

THE March number of the organ of the Geographical Society opens with the paper "On the Road to Merv," read at a recent meeting by Sir H. Rawlinson, which now appears, enriched with valuable notes, and illustrated by a map of the Turkoman Steppe and Northern Khorassan. Mr. C. R. Markham's paper "On the Basin of the Helmund, Western Afghanistan," is also published, accompanied by a well-executed map of the region. The Zulu-

land bibliography and cartography, which have been compiled with much care, will be found very useful at the present time, but it is to be regretted, perhaps, that a map of the country was not added. The geographical notes include accounts of M. Oshanin's further explorations in the Pamir, and of the Loochoo Islands. There is also an obituary notice of M. Nicholas de Khanikoff.

THE Archbishop of Algiers has received a detailed journal of the experiences of the French missionary expedition on its way to Albert and Victoria Nyanza, and Lake Tanganyika, which he has promised to communicate shortly to *Les Missions. Catholiques.* When published in that periodical, it will be accompanied by a map of Equatorial Africa, prepared from original sources of information by Père Charmetant, under whose auspices the expedition started from the east coast.

AT the last meeting of the Society of Commercial Geography at Paris, M. Reclus communicated his report on the exploration of the Isthmus of Darien, conducted under the orders of Lieut. Wyse.

IN the *Bulletin* of the Lyons Geographical Society, which has just been issued, M. Luciano Cordeiro, the learned Secretary of the Lisbon Geographical Society, contributes a second instalment of his papers on the first explorations of Central Africa, and the Portuguese doctrine of African hydrography in the sixteenth century.

NEWS has lately been received by the German African Society from Dr. Buchner, a traveller recently sent out to West Africa. He proposed to leave Loanda towards the end of December for Dondo, on the Quanza, where Major Mechow is delayed by illness.

THE just received *Boletin* of the Madrid Geographical Society for October last contains a lecture by D. Francisco de Paula Arrelaga, on the physical geography of the sea. Also papers on Afghanistan, on Bulgaria, and other eastern countries by Sr. D. Saturnino Giménez, and an account of a journey to Morocco in 1800 by a Spanish Commission.

THE enterprise of Mr. James Gordon Bennett in preparing two vessels for arctic exploration, the one to proceed by way of Spitzbergen and the other by Behring Straits, is already well known to our readers. The steamer *Jeannette* has been assigned to the Behring Straits' service, and is, we understand, already in San Francisco. A bill has been introduced into Congress by Mr. Wood authorising the Secretary of the Navy to accept this vessel and take charge of her. The bill provides that it is to be fitted up with any material on hand, and authority is given to enlist the necessary crew and to provide the naval officers; and the expense, at least the pay of the men, will be subsequently refunded by Mr. Bennett. It is not improbable that this vessel will be made useful in the search for and relief of the *Vega*, Prof. Nordenskjöld's steamer.

NOTES

WE announce with the greatest regret the sad news, just received by telegraph, of the death of Prof. W. K. Clifford at Madeira. We can do no more this week than barely announce this national loss.

THE Emperor of Austria has bestowed upon Dr. Meyer, the director of the Royal Zoological Museum of Dresden, the well-known New Guinea traveller, the order of the Iron Crown.

THE death is announced at Berlin of the well-known chemist, Prof. Sonnenschein. He had reached the age of sixty-two.

THE Council of the Society of Arts have appointed Mr. H. Trueman Wood, Secretary, in the place of the late Mr. P. Le Neve Foster.

ACCORDING to the *Kreuz Zeitung*, Prof. Virchow intends, on the close of the current semester, to accept an invitation of Dr. Schliemann to join him in some excavations at Troy.

THE Italian Ministry of Agriculture, Industry, and Commerce offers a reward of 3,000 lire to the author of the most complete and best monographic essay on the structure, the vital functions, and the diseases of the acid fruits, or species and varieties of the genus *Citrus* and kindred genera, provided that the said work, by a sufficient collection of original observations and experiments, should succeed in furnishing an important addition to the present knowledge concerning such subjects, and thereby supply a scientific criterion for the improvement of the cultivation of these acid fruits and for the cure of their diseases. The date for sending in the works competing for the said prize is fixed for the end of May, 1881. Essays by Italians, or by foreigners written in Italian, are admissible to the competition; but if written in another language they must be accompanied by an Italian translation. The essays sent in for competition are to be sent to the Ministry of Agriculture, Industry, and Commerce, with the superscription, "Competition for the Prizes for the best Essay on the genus *Citrus*," and they must be distinguished by a motto, to be given also in a sealed cover containing the name and address of the author.

IT is intended to make a special effort to issue the Report of the Sheffield Meeting of the British Association at an early date after the meeting. To enable this to be done the Council request that all Reports and Abstracts of all Papers intended to be read in the Sections, may be sent to the Assistant-Secretary not later than July 15, in order that, if approved of by the Organising Committees, they may be put in type before the Meeting. Authors who comply with this request, and whose Papers are accepted, will be furnished *before* the Meeting with printed copies of their Reports or Abstracts. No Report, Paper, or Abstract can be inserted in the volume unless it is in the Assistant Secretary's hands *before the conclusion of the Meeting*.

DR. BOTTOMLEY has called the attention of the Manchester Literary and Philosophical Society to an interesting copy of the "Principia" of Newton. In addition to being an impression of the first edition, it contains the autograph of Edmund Halley. It was a present from Halley to the Abbot Nazari. Nazari was the editor of a scientific journal at Rome from 1668 to 1681. The following is the entry in Halley's hand-writing:—

Illustrissimo Dno
Dro Abbati Nazario
Romæ humillime offert
Edm. Halley.

Subsequently the book was in the possession of Dr. Dalton, and its value is enhanced by his autograph.

M. STEPHAN has been elected a Corresponding Member in the Astronomical Section of the Paris Academy, in place of the late Dr. Hansen, of Gotha.

WE have received one or two letters on the subject of migration of birds, referred to in Col. Donnelly's letter in NATURE, vol. xix. p. 289. Mr. H. Cecil thinks that the most hopeful way of carrying out Col. Donnelly's proposal would be through our consuls. "If a tabular sheet, noting in separate columns the points to observe—drawn up, say, by Mr. A. R. Wallace—were printed on thin paper and transmitted to our consuls abroad, with a request that they would fill them up and remit them to NATURE, my impression is that few would decline. In cases where the consul himself had not the inclination or the time accurately to fill in the paper, he could generally command the services of some one who could. This need in no way interfere with the independent notes of which your correspondent speaks." Mr. Cecil thinks that any funds required could easily be got by subscription. Mr. Allen Harker, of Gloucester, thinks that a student of migration has rather an *embarras de richesse* to contend with than a want of data. "The researches of Middendorf," he writes, "or the admirable work of Dr. Palmen, 'Om foglarnes flyttningsväger,' reviewed in NATURE, vol. xv. p. 465, would furnish your correspondent with much of the

information he desires, not to mention the many published observations of our own ornithologists, which are as reliable as they are voluminous." What is mainly wanted is, he thinks, not so much new records as a tabulation and systematic arrangement of those we already have. Mr. Harker refers to a comprehensive article on "The Migration of Birds," by Lieut.-Col. Drummond Hay, in the *Scottish Naturalist* of last year, which meets in some measure Col. Donnelly's suggestions.

GENERAL MYER has presented M. W. de Fonvielle with an improved weather-indicator in acknowledgment of the services rendered by him during the exhibition in popularising the principles adopted by the U.S. Signal Office. This weather indicator will be exposed in the shop of M. Secretan, the optician of Pont Neuf, and forecasts daily published according to the method adopted by the Signal Office in the several American farmers' post offices.

THE services rendered to meteorology by the observatories of Puy de Dôme and Pic du Midi are so great that it is proposed to establish two others, as we mentioned in our last impression, one on the top of Mont Ventoux, in the south of France, and the other on the top of Ballon de Servance (altitude 1,189 metres) in the department of Vosges. A fort and an electric telegraph having been established recently on the top of that mountain, the expenses will be very small. Two other mountains in the vicinity reach a somewhat higher altitude, but they are on the new frontier, and only a part of them belongs to France. M. Jules Ferry, the new Minister of Public Works, having been born in the Vosges, and being a representative of that department, it is pretty certain he will exhibit the same zeal for this enterprise as M. Bardoux, his predecessor, did for the Puy de Dôme Observatory.

TWO companies are in competition for exhibiting the monster Giffard's captive balloon. One directed by M. Tissandier contemplates continuing the ascents on the site of Cour des Tuileries, but there is some uncertainty whether the old palace will not be restored next summer. A German company offers to establish it at Berlin, on the occasion of the forthcoming International Exhibition.

MDME. SARAH BERNHARD, the celebrated actress, has published a volume on her captive balloon ascents.

IN his last report on the trade and commerce of New Caledonia, Mr. Consul Layard states that he has observed there a great variety of apparently valuable fibres, woods, and oils, which have yet to be developed. He also notes the discovery of a large deposit of good guano on some islands in the prolongation of the reef at the northern end of the island. He considers this somewhat remarkable, as it might have been imagined that the rain which falls in these latitudes would deprive the deposits of much of their valuable constituents. The guano, however, is said to have been tested in Melbourne and Sydney, from which places large orders for its supply have been received.

IN his just-published trade-report H.M.'s Consul at Islay, Peru, mentions that some very rich lodes have been discovered at Caylloma, a district about thirty leagues to the north of where the railway passes at Pampa de Arriero, on the road from Arequipa to Puno. Several parties have surveyed them, and they are supposed to be equal in riches to the famous Caracoles mines in Chile, which created so much excitement a few years back. It has been found, however, that there will be great difficulty in extracting the metal from some of the lodes, which are apparently very rich in silver ore, owing to the damp nature of the ground and the consequent necessity for powerful machinery to draw the water from the mines.

AREQUIPA, Peru, was visited on the night of January 9 by the most severe shock of earthquake that has been felt there since that which destroyed the city on August 13, 1868. The present shock occurred shortly before midnight and caused general consternation. The people quickly left their houses, and rushed frantically through the streets, fearing a repetition of the shock. No other, however, followed at that time, but three days later a long and violent single shock of earthquake occurred also at midnight.

WE are glad to notice that the Ancient Monuments Bill has passed through Committee of the House of Commons, with some slight modifications. We trust that the further stages necessary before the Bill can become law will be got through successfully during the present session.

THE German papers, the *Times* Paris correspondent states, give the following account of an occurrence at Rappelsdorf, in the Erfurt district, which, though dated the 21st of last month, is not uninteresting if true:—"Yesterday, at 5.45 P.M., the water of the Todten Lake suddenly rose with a violent bubbling, flooding the surrounding land for nearly 500 metres, and as suddenly returning to its natural bed. One Rappelsdorf inhabitant will have it that he saw a bubbling pillar of water rise fifty feet out of the lake, and that it burst asunder and spread on every side. During the rise of the water subterranean noises were heard. All that is now to be seen is a deep, gaping rent in the earth, from which from time to time vapour rises. The whole land over which the water spread is covered with innumerable small shells and dead fishes."

FURTHER experiments were made last Thursday in lighting the British Museum reading-room with the electric light. The result showed that by proper arrangement and at a comparatively moderate cost, there is good reason to believe that the end desired can be obtained. The Paris Société Générale d'Électricité have made the experiments at their own cost.

WE learn from the *Colonies and India* that experiments are still being carried on at the Peradeniya Botanic Gardens, Ceylon, with the view of discovering a cure for the leaf-disease in the coffee-tree. Mr. George Wall has devised an ingenious method of applying sulphur fumes to the trees for this purpose. A paper umbrella with a curtain hanging from it, is dropped over the tree, and fastened by the handle, a lighted sulphur fuse is then placed underneath, and it is said that the fumes are retained long enough to attack the spores of the fungus.

AN interesting account, *The Colonies and India* states, has been published in the papers of Barker's Cave, Rosella Plains, North Kennedy district, Queensland, to which place Sub-Inspector Armit had followed the track of a white woman and four black fellows. The tracks were followed for nearly three-quarters of a mile in the cave and then out again. The opening is about 25 feet high and 40 broad, and the average height 40 feet, with a breadth of 60 or 70. For about 180 yards from the mouth some degree of daylight is visible, but after that there is impenetrable darkness. The floor was almost perfectly level for hundreds of yards. A root of ficus was found growing 800 yards from the mouth of the cavern. Some hundreds of yards further on they came to water, and found that no further progress could be made without a canoe. An expedition, provided with a canoe and tools and other implements, is to be sent to make a thorough examination of the cave.

THE competition of Japan teas with those of China and Assam have quite recently received a new impetus. In a recent report on the tea trade of Hiôgo we are told that efforts are being made to stimulate this important native industry by the manufacture of black tea; this it is stated is of the greatest importance to Japan in view of the strong competition that exists between teas produced in the country and those known in trade as Formosa Oolongs, the only great market for both of these kinds being

America, the effect of which has been to reduce prices and consequently to impose a limit upon production. Several hundred piculs of imitation Congou were shipped to London from Hiôgo in the course of last year, and are said to have been favourably received in the market, both quality and flavour being of a high order; the only question remaining to be solved as to the success of these teas is whether they "can be produced at prices low enough to enable them to compete favourably in foreign markets with China and Assam teas."

In the December part of the *Transunti* of the Royal Academy *dei Lincei* of Rome, Prof. Cossa gives an interesting account of his researches on the occurrence of the three metals cerium, didymium, and lanthanum. It appears that although these metals occur always in but minute quantities, yet their occurrence is far more frequent than is generally supposed, Prof. Cossa having been able to trace them even in bones and in the ashes of plants, not to speak of a number of minerals, such as certain apatites, Carrara marble, scheelite, &c. In Carrara marble Prof. Cossa found about two centigrammes of the mixed oxalates of cerium, lanthanum, and didymium in every kilogramme of marble; there were also traces of yttrium.

We have on our table the following works:—"The Elements of Dynamics," second edition, James Blackie (Thin, Edinburgh); "Simple Lessons in Domestic Economy," Wm. Wyley Murly; "Education as a Science," A. Bain (Kegan Paul and Co.); "The Land of Midian," 2 vols., Capt. Burton (Kegan Paul and Co.); "Reise aus den Stillen Ozean," Max Buchner (J. N. Kerns); "The Study of Rocks," Text-Books of Science, Frank Rutley (Longmans); "Dictionary of Chemistry," vol. viii. part 1, Henry Watts (Longmans); "Report of the Recorder of the Botanical Locality Record Club," West (Newman and Co.); "British Burma and its People," Capt. Forbes (Murray); "Life in Asiatic Turkey," E. J. Davis (Stanford); "Geological Survey of Victoria, Report of Progress of the Secretary of Mines" (Trübner); "The Two Voyages of the *Pandora* in 1875 and 1876," Sir Allen Young (Stanford); "Practical Geology," W. J. Harrison (W. Stewart and Co.); "Animal Physiology," Dr. A. Wilson (W. and R. Chambers); "Manual of Practical Chemistry," A. W. Blyth (Chas. Griffin and Co.); "A Ministry of Health," B. W. Richardson (Chatto and Windus); "Morphology of Vertebrate Animals," A. Macalister (Longmans and Co.); "The Colour Sense," Grant Allen (Trübner); "Fuel, its Combustion and Economy," T. Symes Prideaux (Lockwood); "The Evolution of Man," 2 vols., Ernst Haeckel (Kegan Paul and Co.); "Experimental Culture of the Opium Poppy," John Scott (Calcutta Press); "Manual of Opium Husbandry," John Scott (Calcutta Press); "Sewage Poisoning," Edward T. Blake (Hardwicke and Bogue).

The additions to the Zoological Society's Gardens during the past week include a Common Hare (*Lepus europæus*), British Isles, presented by Mrs. F. Buckland; an Impeyan Pheasant (*Lophophorus impeyanus*) from the Himalayas, two Cheer Pheasants (*Phasianus wallichii*) from North India, received in exchange; a Nuthatch (*Sitta cæsia*), British Isles, purchased; a Sambur Deer (*Cervus aristotelis*), born in the Gardens.

THE PHYSICAL NATURE OF THE SUN[1]

The question whether all points of the sun are alike, in reference to the emission of light and heat, is not yet decided. As to the distribution of heat on the sun, many investigations have already been made with a view to answering this important question. Nervander seems to have been the first to discover (from temperature observations at Paris and Innsbruck) a temperature inequality of about ½° R, which has moreover the period of the sun's rotation (27·25 days). Simultaneously, Dr. Buys Ballot made a similar inquiry in Utrecht. Proceeding on the supposition that a kind of heat pole exists in the sun, and that accordingly the rotation of the sun must appear from long series of temperature determinations, he got from observations of temperature at Harlem, Zwanenburg, and Danzig, a period of 27·682 days. Since this result differs so much from that of Nervander, Buys Ballot subjected the calculations of Nervander to a thorough scrutiny, from which he concluded that that observer had "not only taken the moon for the sun, but had also mistaken the former." In his memoir Buys Ballot further showed, that to the colder side of the sun, which was presented to us on 1st January, 1846, a temperature corresponded that was, on an average, about 0·7° lower than that of the warmer side, which was presented to us on 15th January of that year. Carlini and D'Arrest got nearly the same result as Nervander. Airy, on the other hand, was unable to decide from the Greenwich observations. Since by the distinguished researches of Hornstein, Director of the observatory at Prague, and of Broun, it has been proved that the time of the sun's rotation may be deduced from variations of magnetic and barometric phenomena more accurately and from a short series (one year) of observations, and since both the period of Nervander and that of Ballot differ so much from Spoerer's and Carrington's rotation period, I submitted the Prague temperature-observations for 1876 to a closer examination, expecting a much shorter period from these than Hornstein got from magnetic and barometric obserations, as I supposed that it would correspond to the rotation, deduced from spot observations, of the thermal equator of the sun, which, it is known, does not coincide with the true equator. I worked the observations therefore by the method given by Hornstein in the *Sitzungsberichte* of the Vienna Academy (Bd. 67), as it is peculiarly suited for such researches. I here communicate the final result. The most probable value obtained for T was 25·56 days. According to Carrington's observations, the position of the thermal equator of the sun on the foregoing supposition would have the latitude 10° to 20°, according to Spoerer's observations, the latitude 13° to 40°. As recent researches seem to show that the influence of variation of the forces of the sun is reflected in the variations of meteorological phenomena, I further investigated the wind components of the year 1870, in their relation to the rotation-time of the sun. For the east-west-components I found a period of 26·71 days. Whether from this result may be concluded a correspondence between prevalent winds in the sun, such as Spoerer has deduced from his spot observations, will have to be decided by closer investigation.

[1] By Dr. Gruss, in the *Astronomische Nachrichten*.

THE STRUCTURE AND ORIGIN OF LIMESTONES[1]

After the obituary notices of eminent Fellows lost during the past year, who were more than usually numerous, the president confined his own special address to the consideration of the structure and origin of limestones, relying mainly on his own observations, but incorporating general facts derived from other sources. Since, in order to properly understand the nature of the various constituent fragments of which many limestones are composed, it is necessary to know the organic and mineral constitution of the various different living calcareous organisms, this question was first considered from a somewhat novel point of view, and they were regarded, not merely as living tissues, but also as mineralised organisms, much attention being paid to their special optical characters. Much attention had been also paid to their true mineral constitution, so as to ascertain in which groups the carbonate of lime exists in the form of calcite, and in which as aragonite. The results are in some cases remarkable, even in relation to biology, and are of great interest and importance in the study of limestone rocks and their included fossils, since subsequent changes depend mainly on whether the original material was calcite or aragonite. This is due to the fact that calcite is in a state of stable equilibrium, and cannot be changed to aragonite, whereas aragonite is relatively in a state of unstable equilibrium, can be changed to calcite, and usually has so changed in limestone rocks. This circumstance has given rise to a complete difference in the state of preservation of many fossils. When they were originally calcite, they may have been further consolidated, but retain their original structure and optical properties, whereas when they

[1] Abstract of Anniversary Address to the Geological Society by Mr. H. C. Sorby, F.R.S., President, communicated by the author.

were aragonite they have sometimes been completely removed by solution, and in other cases are usually changed into a mass of crystals of calcite, and have lost their original microscopical and optical characters. The general structure of various recent and fossil organisms was then considered, and it was shown how and to what extent they could be distinguished, when occurring as minute fragments in thin sections of limestones.

The various facts connected with the disintegration of shells, corals, and other organisms, are of great importance in studying limestones, since without an adequate knowledge of the manner in which they decay and fall to pieces, very inaccurate conclusions might be formed respecting the origin of calcareous deposits. The results mainly depend on original structure, and on whether they are composed of calcite or aragonite. The next questions considered were the manner in which the external form of minute fragments is preserved in limestone, and the various chemical changes occurring after deposition or consolidation; and, having thus established the general principles necessary for their accurate study, the President entered on a description of our various English limestones, in descending order.

The main object was to ascertain, as far as possible, the exact nature of the material from which each particular rock was derived. Some beds are mainly composed of definite fragments, so as to be analogous to sands, and then the true nature of the various organisms from which the fragments are derived can be ascertained, provided they were originally calcite, whereas, if they were originally aragonite, and their structure lost, very often all that can be said is that they were portions of aragonite shells or corals. Many associated beds are or were composed of fine granules, and analogous to clays. In many cases these have in all probability been derived to a great extent from aragonite organisms decayed down into small granules of calcite, and it is quite impossible to further identify the material.

The structure and origin of oolitic grains was dwelt upon at some length. Usually they are evidence of true chemical deposition. They occur in three distinct types, viz., those composed of aragonite, having a concentric structure without any radii, giving rise with polarised light to a black cross optically positive; those which are composed of calcite, having a radiate structure and giving rise to a negative black cross; and those which have recrystallised since their original formation. After describing the chief points of interest connected with the leading limestone rocks of our country, the president collected together the results into two tables, the more condensed of which may here be given.

Name of rocks.	Chief constituent fragments, &c., in descending order.
Cretaceous	Shell prisms, Foraminifera, Coccoliths.
Wealden	Freshwater aragonite mollusca, Entomostraca.
Jurassic	Chemical deposits, Aragonite mollusca and corals, Brachiopoda, Echinoderms, Shell prisms.
Permian	Original structure lost by dolomitisation.
Carboniferous ...	Encrinites, Brachiopoda, Foraminifera, Corals, and Polyozoa.
Devonian	Encrinites, Corals, and allied organisms.
Silurian	Encrinites, Corals and Polyzoa, Brachiopoda, Trilobites.
Metamorphic ...	Original structure lost, Quartz and Silicates formed *in situ*.

He concluded as follows:—

"On examining these tables, especially the more detailed ones, it will be seen how remarkably and characteristically our limestones differ from one another. There would usually be little difficulty in deciding the general age of any characteristic, somewhat coarse-grained, specimen. Though this difference must to a great extent have depended on the nature of the organisms living at each period, yet it must also have depended on the accompanying mechanical and chemical conditions of the water in which the deposits were formed. The structure of each rock was therefore dependent on two most important circumstances, and we need not be surprised to find the results so varied and characteristic. Passing upwards from the earlier rocks, we may often trace a gradual change, broken here and there by a complete contrast, which is in perfect agreement with results arrived at from a totally different class of facts. On the whole, this is perhaps the most important conclusion that we can at present draw from the subject before us. Possibly further research may teach us much more, since I am quite sure that much remains to be learned. In fact, long as I have studied these questions, and long as this address has been, I know quite enough of the facts to be convinced that it is only a sort of first attempt and rough sketch of a very wide and complex subject."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

MR. MILMAN, who for some years has acted as Assistant-Registrar, has been appointed to succeed Dr. Carpenter as Registrar of London University. It is stated that Mr. H. N. Moseley is a candidate for the Assistant-Registrarship.

MR. A. CRAIG-CHRISTIE, F.L.S., lecturer on botany, Edinburgh, is a candidate for the Chair of Botany in the University of Edinburgh.

IN a recent report by the British Consul at Hakodate, some account is given of the public buildings and other institutions of Sappora and Ishcari. Referring to the Agricultural College buildings, we are told that they consist of four distinct houses, as follows:—A two-storeyed house, comprising lecture and recitation-rooms, cabinets, and offices. A one-storeyed house, used for dormitories to accommodate from fifty to sixty students, attached to which is a similar building providing a large dining-hall, kitchen, bath-rooms, offices, and servants' quarters. In connection with this, again, is a two-storeyed building, which serves as a lecture-room and a general sitting-room and study. A two-storeyed house, which is the chemical laboratory; the ground-floor of this house is used as a general laboratory for the students, and on the second floor are the lecture and apparatus-rooms, and the rooms for collections in mineralogy, geology, and chemistry. Besides these there are several other buildings in European style, used for various scientific and industrial purposes. It is further intended to erect, at an early date, an Agricultural College, likewise two-storeyed, which will be another imposing building. Here will be zoological, mineralogical, geological, botanical, and agricultural museums, with separate halls for lectures and experiments in the above-mentioned branches. The Sapporo Agricultural College was founded by the Kaitakushi for the education and practical training of young men from all parts of the Empire, who are expected to remain in the Government service in Yesso, after graduation for a term of five years. The number of students is limited to sixty, and all their expenses while in college are defrayed by the government. Candidates for admission must be at least sixteen years of age, of sound constitution and good character. They will be examined orally and in writing in the Japanese and English languages (which they are expected to read, write, and speak correctly and fluently), arithmetic, geography, and universal history. If they succeed in this preliminary examination they will have to sign a prescribed contract with the government and furnish a satisfactory surety or guarantee. The course of instruction will occupy four years and embrace all the branches of a general education, with the study of the Japanese and English languages. Moreover, they will be thoroughly instructed in agriculture and horticulture, civil engineering, and chemistry, astronomy, botany, geology, zoology, military science and tactics, and before they leave college, in the fourth year, they will have to devote some time to political economy. As the students are destined to become practical agriculturists, including the use of hand implements and machinery, and the care and management of domestic animals, they have to work in the fields with their foreign instructor two afternoons of each week. There are at present three foreign professors or instructors, viz., one for mathematics and engineering, one for botany and chemistry, and one for agriculture, besides the native teachers, and it is expected that later will be added an instructor for military drill, and one specially for the English language, and a foreign doctor. The number of students at the time the report was written amounted to thirty, fifteen being added annually up to sixty in the fourth year of the foundation of the college, when the first batch of fifteen (the original number started with) will retire and graduate if they have completed their course of studies in a satisfactory manner, whereupon they will enter government employ. In another part of the report, speaking of the progress made by the students, the reporter says, "they are most assiduous at their studies, and it is indeed astonishing the progress they have already made. All their studies are conducted in English, and they speak and discuss in English without the slightest hesitation, making use of very good language. They also appear to enter fully into the different branches of study."

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 1, 1879.—This begins with a portion of an extended inquiry by Herr F. Kohlrausch into the electric conductivity of aqueous solutions of hydrates and salts of the light metals, as also of sulphate of copper, sulphate of zinc, and nitrate of silver. The paper is in three parts—an experimental, a practical, and a theoretical (the first two in this number). The practical part gives tables for use, and formulæ of conductivity, especially of dilute solutions; specifies bodies which show a maximum of conducting power at a degree of concentration of solution below saturation, indicates liquids which commend themselves as a standard for electric conductivity, &c.—Herr W. Kohlrausch furnishes an experimental determination of the velocities of light in crystals. He employed the new instrument called a total reflectometer, and he comes to the conclusion that Fresnel's theory of double refraction in optically uni- and biaxial crystals gives a form of light wave-surfaces, which, within very small errors of measurement, is in general experimentally confirmed for uniaxial crystals, and for the principal sections of biaxial crystals.—Herr Groshaus contributes some interesting observations on the densities of substances in the gaseous and liquid states, in relation to their chemical composition.—Herr Ritter calculates that the quantity of heat radiated annually from the sun 75,000 years ago must have been about 1 per cent. less than at present (700,000 years ago about 10 per cent. less), a result which is supposed to explain the "glacial period," while the previous tropical climate is accounted for by a less thickness of the solid crust of the earth. He also estimates that each kilogramme of the sun's mass contains on an average about 43,000,000 units of heat.—Herr Wiedemann declines to regard the oxide containing copper separated electrolytically from solutions of acetate of cupric oxide, as a peculiar allotropic modification of copper.—There are also papers on the thermo-electric properties of apatite, brucite, &c. (Hankel), the theory and application of electro-magnetic rotation (Margules), the influence of temperature on galvanic conductivity of liquids (Exner and Goldschmiedt), and two new fluorescent substances (Lommel).

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 27.—"Studies in Acoustics. I. On the Synthetic Examination of Vowel Sounds." By William Henry Preece and Augustus Stroh.

The authors had studied the formation of vowel-sounds on Helmholtz's theory, and had succeeded in constructing an instrument which reproduced the principal vowels with greater distinctness and accuracy than the phonograph, and which fully confirmed that theory. In the pursuit of this study they constructed a new phonautograph, a machine for drawing harmonic curves either on paper or on smoked glass, compounded of one or many partials varying in phase and amplitude, called a "synthetic curve machine," a new syren, a new musical instrument dependent on the vibration of a diaphragm and several instruments for reproducing vowel-sounds. They had also studied the intensity of sound, and showed experimentally how loudness was dependent on the quantity of air thrown into vibration, and independent of the amplitude of vibration of the sonorous body which remained constant. They also introduced a new stereoscopic slide, which rendered very complicated curves perfectly perspective.

Linnean Society, February 20.—Prof. Allman, F.R.S., president, in the chair.—The Rev. G. Henslow exhibited portions of an elm bough having a pulley centrally imbedded; exteriorly all trace of its presence was obliterated, and the wood-growth indicated thirteen years subsequent to the entrance of the foreign body.—Mr. R. Bowdler Sharpe showed and commented on a series of rare birds. Among those from New Guinea were skins of *Paradisea raggiana*, collected by the Rev. Mr. Lawes; of others obtained in the Fijis by Baron von Hugel were species of the genus *Pinarolestes*, which also inhabit Tutuela, one of the Samoan Islands.—Mr. W. H. Fitch passed round a coloured drawing of a remarkable large crimson-coloured pitcher (twelve inches long by nine in circumference) of *Nepenthes sanguinea*, grown at Bury, by Mr. O. Wrigley.—A paper was read by Dr. H. Trimen, on the genus *Oudneya*, Brown. This is a small cruciferous shrub discovered by Dr. Oudney in the desert between Tripoli and Mourzuk. The genus has been obscure in consequence of Brown's short insufficient diagnosis. This latter Cosson has shown to be a *Moricandia*, hence Brown's genus has been doubtfully referred to the same. Dr. Trimen shows from an examination of Oudney's herbarium in the British Museum, that *Oudneya* is identical with *Henophyton*, Coss., which name will supersede, having the priority of thirty-one years.—The abstract of a communication on some South American genera of plants of uncertain position, by Mr. John Miers, was read by the Secretary. The author refers the *Pleoaginea* of Arruda da Camara, who mentions three species belonging to the Chryobalanaceæ, but of which two only should be retained in that genus, the third belonging to the true *Conepia*, Aublet. Among *Parinarium* the two species described and figured by Aublet alone ought to be retained. Those to be excluded are the two British Guiana species of Bentham, and seven others of Brazilian origin described by Dr. Hooker, and which from their floral structure and development of fruit do not differ from *Licania*. The Malayan species of Blume are now shown to belong to the *Petrocarya*, Jack., while the African species enumerated by De Candolle, together with five others yet undescribed, must be referred to *Griffonia*, Benth. and Hook., a genus notable for the conferrumination of the cotyledon of the embryo. The genus *Minquartia*, Aubl., belongs to the Crescentiaceæ, as does *Senapea*. Bentham's and De Candolle's *Kigelia* are widely different, the *K. africana*, Benth., properly belonging to *Tripinnaria*. The genus *Managa*, Aubl., Mr. Miers avers belongs to the Aurantiaceæ; *Racceria*, Aubl., does not come under Sapindaceæ, as De Candolle supposed, but to the Meliaceæ, and is allied to *Melia* and *Azenderachta*, Juss.—Dr. Maxwell Masters next gave the chief points of a paper on the inflorescence of Crassulaceæ. Though devoted chiefly to this group he discussed the schemes of classification proposed by Roeper, Bravais, and others, as also the emendations of Hofmeister, Sachs, and the modern German school of botanists. He proposed a rearrangement under the heads of Monopodial, or indefinite; Choripodial, or dichotomous; and Pleiopodal, or definite; the latter comprising the Sympodial varieties. The modifications brought about by suppressions, adhesions, congenital or otherwise, real or apparent, and by displacement of varying kind and degree were alluded to, the general conclusion being that while suppressions and adhesions do occasionally occur, yet that in most instances the phenomena witnessed might easily be explained by displacement of parts, and especially by that process of elongation known as up-lifting. The history of development, as well as the internal structure, he believes are consistent with this latter view, but not, as a rule, with the theory of adhesion.—Messrs. Ed. A. Fitch, Laurence Scott, and Wm. Stone were elected Fellows of the Society.

Chemical Society, February 20.—Dr. Gladstone, president, in the chair.—The following papers were read:—On colouring-matters derived from diazo compounds, by Dr. O. N. Witt. For some time after the introduction of anilin dyes, though magentas, violets, and blues were obtained in profusion, no choice of yellow or green anilin dyes was to be had. A few years back, however, a beautiful yellow dye, chrysoïdin, was described by Hofmann, and since that time numerous patents have been taken out for the manufacture of similar substances. In the present paper the author gives an account of these various substances, which are oxy or amido derivatives of azobenzene, including the different tropæolins.—Investigations into the action of substances in the nascent and occluded conditions; hydrogen, continued by Dr. Gladstone and Mr. Tribe. The authors have investigated the actions of nascent hydrogen obtained by electrolysis and hydrogen occluded in palladium or platinum on nitric and sulphuric acids; they establish a close similarity of character, and therefore of condition between the so-called nascent hydrogen and the hydrogen occluded by metals.—On some methods of vapour density determinations, by Mr. J. T. Brown. The author criticises the methods and formulæ of previous experimenters, and suggests the determination of the vapour tensions of mercury by estimating the vapour tension of a substance over Wood's metal and over mercury at different temperatures.—On the decomposition products of quinine and the allied alkaloids, by Mr. J. J. Dobbie and Dr. W. Ramsay. The authors have oxidised the four principal alkaloids derived from cinchona bark, and find that they all yield, on oxidation, the same acid, tricarbopyridenic acid. They also point out that there is a close relation between the cinchona bark alkaloids and the bases of the pyridin series.

Geological Society, February 5.—Henry Clifton Sorby, F.R.S., president, in the chair.—Arthur Ernest Baldwin, James

Farie, Benjamin Neeve Peach, were elected Fellows of the Society.—The President announced the receipt of a legacy of 1,000*l.* bequeathed to the Society by the late Sydney Ellis, Esq., of The Park, Nottingham.—The following communications were read:—On the occurrence of pebbles with Upper-Ludlow fossils in the lower carboniferous conglomerates of North Wales, by Aubrey Strahan, F.G.S., and Alfred O. Walker, F.L.S. The authors described the mode of occurrence near Abergele of certain lower carboniferous conglomerates, best exposed in Ffernant Dingle, and especially of one containing numerous red and green sandstone pebbles, which inclose fossils of Upper-Ludlow forms, and lying above the so-called "bastard limestone." From the arrangement of the beds the authors believe that they may have been deposited against a bank or sloping surface of Wenlock shale; and they state that the great majority of the pebbles in the conglomerate are quite unlike any rock known in the district, but closely resemble the Upper-Ludlow beds of Kendal and Central Wales. The authors discuss the origin of the pebbles, and suggest "the probable extension of the Ludlow beds under Lancashire as the most likely source from which they can have been derived."—On a new group of pre-Cambrian rocks (the Arvonian) in Pembrokeshire, by Henry Hicks, F.G.S.; with an appendix on their microscopic structure by T. Davies, F.G.S. In some new areas of pre-Cambrian rocks, discovered by the author last summer in Pembrokeshire, some rocks of a character hitherto unrecognised in this country were made out. As they were found to hold there, and subsequently also in other areas, a very definite stratigraphical position, with a vertical thickness of several thousand feet, they have been separated by the author from the other pre-Cambrian groups under the distinctive name of Arvonian. They were also found to occupy an intermediate position between the Dimetian and Pebidian formations, and at all points, so far as could be made out, appeared to be separated from each of those formations by stratigraphical breaks. The new areas where they are chiefly exposed are situated some few miles to the north of Haverfordwest, where they form ridges running in a direction from north-east to south-west. They occupy an average width of about a mile, attain at some points to a height of nearly 600 feet, and together have a length of over nine miles. The rocks are flanked by Pebidian and Cambrian beds along their north-west borders, and on the south-east Silurian rocks have been brought against them by faults. In general appearance, as well as in their more minute lithological characters, they are easily distinguished from any of the rocks hitherto described by the author as characteristic of the Dimetian and Pebidian groups in Pembrokeshire. They are, however, so closely allied to some of the true "hälleflinta" rocks of Sweden, that it seems to the author and Mr. Davies that this is the name that should be applied to them in a petrological sense. The author and Mr. Davies believe the origin of the rock to have been a sedimentary one.—On the pre-Cambrian (Dimetian, Arvonian, and Pebidian) rocks of Caernarvonshire and Anglesey, by Henry Hicks, F.G.S.; with an appendix on their microscopic structure by the Rev. Prof. T. G. Bonney, F.R.S. In this paper the author gave the results of some further researches made in Caernarvonshire and Anglesey since his previous communication to the Society on December 5, 1877. A brief statement of some of the results was read at the last meeting of the British Association in Dublin; but much additional evidence was now brought forward, besides many important facts obtained since by microscopical examination of the rocks.—On the quartz-felsite and associated rocks at the base of the Cambrian series in north-western Caernarvonshire, by the Rev. Prof. T. G. Bonney, F.R.S. The great masses of quartz-felsite (or quartz-porphyry) which occur in the vicinity of Bangor, Caernarvon, and Llyn Padarn, are coloured in the Survey map as intrusive, and in the memoir regarded as most probably the result of an extreme metamorphosis of the lower beds of the Cambrian series. The author showed that these quartz-felsites exhibited, in places, all the characteristics of true igneous rocks.—On the metamorphic series between Twt Hill, Caernarvon, and Port Dinorwic, by the Rev. Prof. T. G. Bonney, F.R.S., and F. T. S. Houghton, B.A. In the Geological Survey map this district is coloured as "intrusive felsite," together with those spoken of in the last paper. It was asserted to be probably metamorphic rock by Prof. Hughes and Dr. Hicks in a communication made to the Society last year, and the first author confirmed that view by microscopic examination of a specimen collected by them. The authors had during the past autumn more minutely examined the district, and found: 1. That the general character of the series was that of a metamorphic one; 2. That the rocks of granitoid aspect were associated with well-marked beds of conglomerate; 3. That this series extended up to a little beyond Port Dinorwic, where the quartz-felsite set in. The paper described the microscopic structure of some of the rocks, and the author expressed the opinion that the more granitoid specimens were probably the results of alterations of felspathic grits.

Physical Society, February 22.—Prof. W. G. Adams, in the chair.—New Members: Rev. Coutts Trotter, Prof. G. D. Living, J. C. Adams, F. W. Paterson.—Dr. C. W. Siemens described his new electric current regulator. A necessary condition of the transmission of power to a distance by electricity along a single conductor and re-distributing it by means of branch circuits to separate electric lamps or motors, is that the current strength in each lamp shall be practically uniform. Otherwise the current flowing in the whole branch varies. Hence the necessity of a regulator to regulate the flow of current so as to keep it uniform, however the resistance of the circuit or the electromotive force of the source may vary. The author believes that by properly arranging a number of dynamo-electric machines, either in series or parallel (for intensity or quantity), at each end of the wire, a vast amount of power may be sent along a small copper conductor successfully, provided the distribution is properly regulated. He has designed a regulator based on the heating of a wire by the passage of a current through it. A fine strip of mild steel $\frac{1}{10}$mm. thick is stretched horizontally between two terminals. An upright spindle is supported by means of an insulating foot, upon the middle of this strip, in such a manner that, as the strip bends or sags by its expansion, the spindle sinks with it. Now this spindle carries at its top a table or plate of metal (or, as the case may be, a set of radial springs), and as the spindle rises or sinks to different heights, this plate or these springs make contact with other springs set radially round; and these contacts take out from or throw in resistance coils into the circuit of the current. The sensitive strip is so thin that it may be regarded as a radiating *surface* merely, and it may be assumed that its temperature, due to heating by the current, balances itself with the radiation instantaneously. After passing through the steel strip, the current flows through the coils thrown into circuit, and, by the arrangement we have described, if the current increase so as to over-heat the strip, the latter sags a little more, the spindle sinks, and the consequence is that one or more of the spring contacts is broken, and one or more coils inserted in circuit. A rise of 1° F. in the temperature of the strip is sufficient to liberate two or three of these coils. The fact that the temperature of the strip varies as the square of the current, favours the sensibility of the apparatus. An older form of this apparatus, having pendulous contacts, was also shown; also a regulator in which the expansion by heating of a sensitive wire caused the resistance of several carbon buttons in contact to vary through the pressure exerted on them by means of a bell-crank lever. Dr. Siemens had not been able to prepare carbons which gave the wide variations of resistance obtained by Mr. Edison. Siemens' regulator can also be used as a current meter by causing the sensitive strip to actuate a lever carrying at its end a pencil writing on a moving paper. Dr. Coffin said that he had thought of a regulator in which the heating of a wire spiral in a gaseous chamber would cause the gas to expand and drive up a mercury column past a series of contacts which would throw resistances in circuit. Dr. Guthrie suspected, from some experiments of his, that the conductivity of conductors was not strictly proportional to their sectional area.—Dr. Schuster then gave the results of some observations of his on the spectrum of lightning. These were made by a spectroscope with two prisms, one for the red and the other for the blue end of the spectrum, which were shifted into the line of sight by a chamber arrangement. Thre observations were made: one at Las Animas, one at Manitou, and one at Salt Lake City last year. These showed the three nitrogen lines with three well-defined bands and one doubtfu band. The nitrogen lines correspond to the spectrum of air and the bands appear to Dr. Schuster to agree with the spectrum of the light round the negative pole of the spark in a tube containing oxygen with adulteration of carbonic oxide.—Prof. Ayrton then exhibited an exisothermal model of a cooling globe, the globe in question being a trachyte earth 8,000 miles in diameter. The model gives graphically the temperature of every single part of the earth from the moment when it was at the temperature of

molten trachyte down to 800,000,000,000 years afterwards, that is, long after the present era.

Royal Microscopical Society, February 12.—Annual meeting.—H. J. Slack, president, in the chair.—The report of the council was presented and read by the Secretary.—The president read his annual address, in which the oil immersion objectives and the recent discussion on fermentation were referred to.—Dr. L. S. Beale, F.R.S., was elected President.—Herr Petzold's slides of insects, kindly lent by the editor of NATURE, were exhibited, also catoptric immersion illuminator, by Mr. Stephenson, and microscopes by Mr. Crisp.

BOSTON, U.S.A.

American Academy of Arts and Sciences, February 12.—Hon. Charles Francis Adams in the chair.—Prof. Pickering announced the completion of the observations of the zone assigned to the Harvard College Observatory in the revision of the *Durchmusterung* of Argelander. The observer, Prof. W. A. Rogers, has devoted in this work a large portion of his time for the past eight years. The stars are all included between 49° 50′ and 55° 10′ N., and number over 8,000. The accuracy required has made the work very laborious, the total number of observing hours being greater than was required in the Catalogue of Argelander, containing the approximate places of over 300,000 stars. The deductions are still to be made, and will require some years.—Prof. N. S. Shaler read a paper on the explosion of coal-dust in mines, and suggested that a solution of calcium chloride, which is obtained at no other expense than the cost of preparation from the water of salt works, be driven in the form of spray against the walls of the mine in order to fix the dust in a deliquescent substance upon the walls.—Prof. Asa Gray read a paper on the characters of some new genera and species of plants, chiefly of California and Oregon.—Mr. Thomas P. James made some remarks upon American bryology and some new species of mosses described by himself and Leo Lesquereux.—Mr. N. D. C. Hodges presented a paper on a new absolute galvanometer. The current is measured by its effect in changing the time of vibration of a magnet with its axis parallel to that of the coil. Mr. Hodges also presented a method of determining the reduction-factors of a tangent galvanometer for all deflections when the value for any one is known. By measuring a current by the deflection and then with the same coil and magnet, by the change in time of vibration, the ratio between the reduction-factor of the instrument when the magnet makes any angle with the plane of the coil to its value when the magnet is perpendicular to the coil may be found.

PARIS

Academy of Sciences, February 24.—M. Daubrée in the chair.—The following papers were read:—On the induced currents resulting from movement of a bobbin across an electromagnetic system, by M. Du Moncel. *Inter alia*, the direction of induced currents caused by a given movement of a bobbin before a magnetic pole may be diametrically opposite, according as the movement is tangential or normal to the pole, and the magnetic core on which the bobbin glides is in contact with the inducing pole, or distant from it.—Observations on M. Planté's recent work, "Researches on Electricity," by M. Becquerel. These researches relate to secondary currents.—On the hemihedric forms of alums, by M. Lecoq de Boisbaudran.—Resistance to change of state of crystalline faces in presence of their mother-water, by the same. The passage from a state of very slow dissolution to one of very slow growth does not take place suddenly; each face rests intact, while the mother-water varies within certain limits. There is no mobile equilibrium or exchange of molecules between a crystalline face and its mother-water, but merely erosion or continuous deposit, and, between the limits of resistance to change of state, neither erosion nor deposit. The resistance to change of state is modified independently for each system of faces.—Experiments on a modification which has been made in the sluice of Aubois, permitting the suppression of the alternate motion of vessels in the lock, by M. de Caligny.—Reflections on M. de Lesseps' communication regarding contagion of the plague, by M. Bouillaud. Considering the plague contagious, he says the important problem now is to ascertain the nature of the *principle* or *agent* by which it is communicated.—M. de Lesseps presented the reports he had drawn up for the Alexandrian authorities during the plague in Egypt in 1834-35.—M. Stephan was elected Correspondent in the Section of Astronomy, in place of the late M. Hansen, of Gotha.—On latex during the germinative evolution of *Tragopogon porrifolius*, &c. (continued), by M. Faivre.—Observations of eclipses of Jupiter's satellites, made at the observatory of Toulouse in 1878, by M. Baillaud.—Direct photography of solar protuberances without use of the spectroscope, by M. Zenger. He puts on the sensitive plate, before a very short exposure, a solution of pyrogallic acid and citrate of silver, and uses a layer which absorbs all the rays composing the light of the corona and the solar protuberances.—Geometrical laws of deformations produced by a force applied at a point of an indefinite solid, and calculation of the error fallen into, when, according to the principles of classical mechanics, one conceives this point of application displaced by a certain quantity in direction of the force, by M. Boussinesq.—Projection of molecular shadows, by Mr. Crookes.—Action of different coloured lights on a layer of bromide of silver impregnated with different organic colouring matters, by M. Cros.—On plates sensitised with tincture of mallow or black-currant, the direct spectrum of the Drummond lamp is inactive in all the middle green, while the red and violet extremities are very active. With carthamine, again, the middle part is most active. With chlorophyll the action continues throughout the visible spectrum and a little beyond it, presenting several minima and maxima. M. Becquerel pointed out that these researches had been to some extent anticipated.—On the production of crystallised chromate of baryta, by M. Bourgeois. This gives some new results by the method of calcining an alkaline chromate with the chloride of the metal which is desired to enter into the saline combination.—On the composition of beer yeast, by MM. Schutzenberger and Destrem. Yeast contains complex compounds both hydrocarbonised and proteic, formed like glucosides, and easily decomposed by acids and alkalies.—On pyrogenic carburets of American petroleum, by M. Prunier. He has obtained carburets with considerably more carbon than any compounds hitherto known (97 per cent., the highest previously 95 per cent.).—On glycide, by M. Hanriot.—On the generation of aniline-black by chromates in presence of chlorates, by M. Grawitz. He disproves M. Witz's recent assertion against this.—On various selenides of lead and copper from the Cordilleras of the Andes, by M. Pisani.—On the presence of a segmentary organ in endoproct Bryozoa, by M. Joliet.—On the segmentary organs and the genital glands of sedentary polychætous Annelides, by M. Cosmorie.—On the scales of osseous fish, by M. Carlet. He describes the effects of colouring with picro-carminate of ammonia, and of subjecting to polarised light.—On the mode of employment of telephones at the Artillery School of Clermont, by M. de Champvallier. The success realised is attributed to the method of regulating the position of the magnet. The milled button for turning the screw has at its base a pointer (at right angles to the axis) which moves over a circle of copper. The positions of this pointer for distinct transmission one way or the other are noted.

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